Jas R Peacock


THE
GREAT
INDUSTRIES
OF THE
UNITED
STATES.

THE

GREAT INDUSTRIES

OF THE

UNITED STATES:

BEING

AN HISTORICAL SUMMARY OF THE ORIGIN, GROWTH, AND PERFECTION OF THE CHIEF INDUSTRIAL ARTS OF THIS COUNTRY:

BY

HORACE GREELEY, LEON CASE, EDWARD HOWLAND, JOHN B. GOUGH, PHILIP RIPLEY, F. B. PERKINS, J. B. LYMAN, ALBERT BRISBANE, REV. E. E. HALL, AND OTHER EMINENT WRITERS UPON POLITICAL AND SOCIAL ECONOMY, MECHANICS, MANUFACTURES, ETC., ETC.

With over 450 Illustrations.

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PREFACE.

In the following work, the design of the publishers has been, not only to memorialize the great enterprises of manufacture of the day in the United States, but to make clear to the general reader the processes and mysteries of the various manufactures noted, as well. No pains have been spared, in the matter of general study and special investigation, to make each article as nearly perfect as necessary to convey an adequate impression of the magnitude of the manufactures treated upon, their mechanical subtilties, and everything connected therewith, of which the "inquiring mind" may properly desire to be informed.

They only who have contemplated the state of manufactures as they exist in the United States, understand at all adequately how great a part these play in the history of modern civilization, or how much is to be learned, by each participant in a special art, of the value and importance to humanity at large, of every other art.

There is a more or less anxious desire, upon the part of every skilled man in particular, in any branch of industry, to know something of the character and pursuits of his fellow-men in every other art of importance; and it is the design of the writers hereof to offer to such, an insight into the various arts which distinguish the present period of scientific industry in the United States of America.

That the people of this country do—all things considered—outvie, by positive and original inventions, in the promotion of

art, and of the useful arts especially, as well as by their absorption of the genius of other nations, all the peoples of the civilized world, there can be but little doubt. However superficial may be the expression of a given art in the United States (for which, as a people, we have sometimes been reproached by more or less intelligent and candid visitors from other lands), it must be acknowledged by the just everywhere, that, in the aggregate, the United States have made giant steps, even in the last few years, in the prosecution of every class of ingenious industry. In fact, within the boundaries of the nation is to be found something in the way of current enterprise and industry, illustrative of the genius of all peoples (and of all times which fitly bear upon the present age, as the aggregate necessary response of the past to the wants of the present), of which both the scholar and the active mechanic, as well as the laboring man of every degree, ought and wishes, to know more than ordinarily falls to the lot of any one man's knowledge without arduous and pains-taking study. To administer to such desires this work has been projected, and it is confidently believed that its design has been so faithfully carried out, as to leave but little, if anything, more to be desired for the end in view, than will be found in its pages.

The writers of this work have been necessarily limited and restrained in some respects; for the past history of some arts, in their struggle through invention, opposing circumstances, etc., has not been so well preserved as that of some other arts. But, in the general, something of worth has been recorded of each.

As a record of manufactures in their present condition, it is believed that this summary not only supplies a want long felt among general readers, but that it will do much toward encouraging in this country that appreciation and study of the arts,

from the high stand-point of science, which are so desirable in every nation.

Especial care has been taken with each article in order that it might discuss its special subject in a manner comprehensible by all classes of readers, the young as well as the old; and the design of the publishers, which it is believed has been regarded throughout, has been that nothing of a questionable character in the statement of facts comprised in any article, should find place. That the labor of producing "The Great Industries" has been enormous, the reader in order to understand has but to consider that the history of each art has been traced to its origin through countless volumes, if the art is really antique; and its present condition, processes of manufacture, etc., derived by the personal investigation, inspection, and laborious study of the several writers employed.

The aim of this work is to give the reader a general (and in all cases something in detail) "speaking acquaintance" with whatever is discussed herein. The great, chief ambition of the human intellect is to know something at least of everything; and "to know" is certainly a laudable desire.

Without specially noting any particular industry so far as its respective actors or promotors are concerned, this book not only makes record of leading manufactures as they exist, but of the principal manufacturers of the day noted for their especial worth, as great, leading men, making their mark upon the times, and entitled to a place in a work which must necessarily, as a record of the times, hand their names on, if not to immortality, to many generations which are to come. The pride of the nation is in its children, and in none of these so much as in those who preëminently distinguish themselves in the arts of peace—in domestic manufacture; for these have wrought out in great part the nation's weal, furnishing occupation and a lucrative

"sphere for labor" for thousands and tens of thousands, who, thus employed, have achieved for themselves and their families successes, as well as realized a happier current life, which they could never have won and enjoyed save under the guidance and skill of the more enterprising and far-sighted. Out of the plodding ways of life, which the feudal ages, for example, imposed upon the race, there was evidently no passage, except that which the inventor and the manufacturer have opened. Though prompted in the main by the spirit of self-aggrandizement, these men have proved themselves, nevertheless, the chief philanthropists of the times, and have borne the standard of progress on to its great victories.

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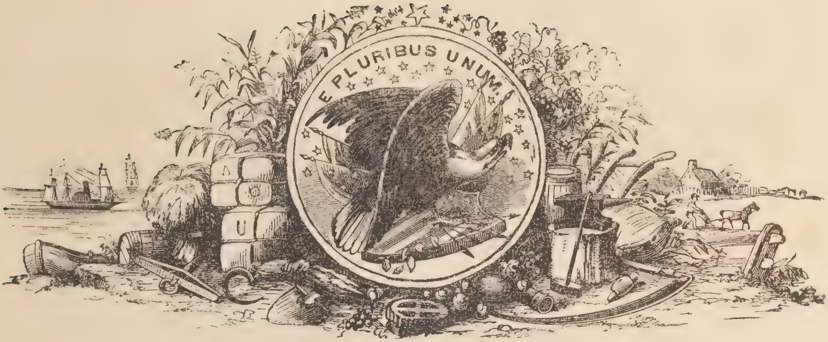

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MAINE.

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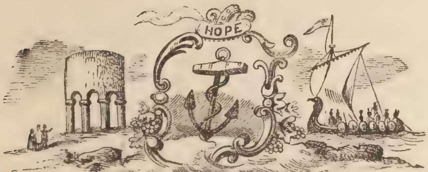

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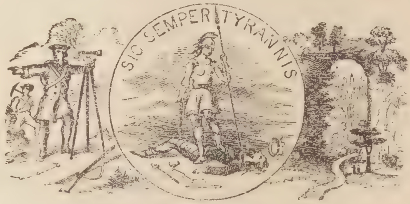

VIRGINIA.

WEST VIRGINIA.

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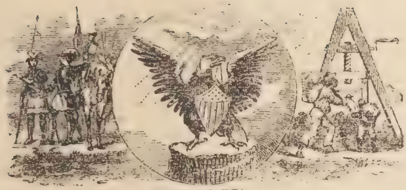

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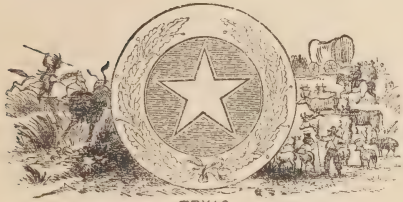

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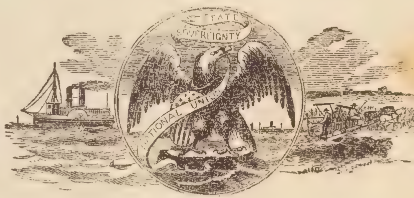

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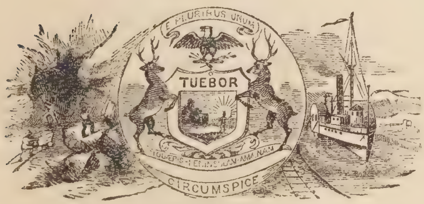

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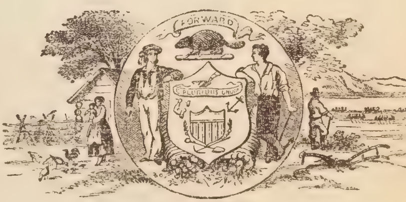

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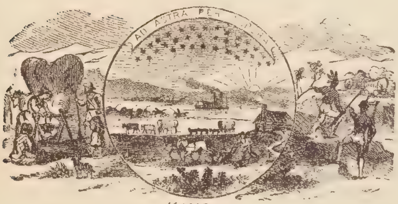

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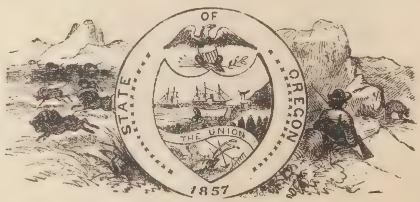

OREGON.

CALIFORNIA.

UNITED STATES.

THE GREAT INDUSTRIES

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UNITED STATES.

AN HISTORICAL SKETCH OF THE PROGRESS OF INDUSTRY IN THE UNITED STATES.

The Value of Industry.

It is quite within modern times that, by observation and experience, the knowledge has been acquired for a comprehensive and philosophical conception of the importance of industry as a necessary condition in the evolution of human society. The position of man in the world, and his social destiny, could not be understood until, by experience, the data necessary for arriving at a philosophic generalization concerning it were obtained, any more than the position of the world itself in the solar system could be known until, by the same process, the data needed for its comprehension had been gathered.

The brilliant results which have followed, in modern times, from the inauguration of a scientific method of inquiry, though perhaps more apparent in the physical sciences, are of no less value in the department of sociology. The field of social science has been opened, and the method has been indicated by which the complex questions of social progress can alone be studied with positive and enduring results. With the growing perception of the relativity of all knowledge, mankind has become aware of the interdependence of the sciences, and that upon industry — upon our ability to modify the conditions in which we are placed — can we alone depend for our advance in the path of progress.

In the study of industry, and of its effects upon the growth of civilization, and also of the effects produced upon industry by

political and other causes, the United States offer a most important and suggestive field. In the first place, our history is complete; the beginning of the nation dates from a definite historical period, and the foundation of its industry is not lost in the obscuring mists of tradition. Then, again, the political constitution of the country, its social equality, and the necessities of the new conditions of its settlement, all conspired to make more evident the fact that productive industry is of necessity the foundation of all progress in civilization.

The Influence of the United States.

In the democratic movement of modern times, America appears destined to perform a similar office for the world that the discovery of the country in the fifteenth century did for the knowledge of mankind concerning the form of the world, and its position in the solar system. At the period of the settlement of the country, the industry of Europe had begun to feel the influence of the increased knowledge of the world gained by the enterprising spirit of navigation, which, during the preceding century, had supplemented the discovery of America by the circumnavigation of the world, and of the new spirit of independence and investigation which, thus brilliantly vindicated in the domain of physical research, excited the minds of all those who were not drugged by superstition, or bound helplessly by tradition, to apply the same methods to the existing conditions of their religious, their social, and their political organizations. As with all movements of advancing social organization, the commencement was made in the popular discontent with the existing conditions, before it found an expression in the literature or the political action of the times. It was the popular demand for books which stimulated the invention of printing, as it was the spirit of the times to which Luther gave expression which made the reformation possible; and later, when Voltaire, in his historical works, made the first expression in literature of the importance of studying the opinions and the condition of the people, rather than the whims and ambitions of kings, for obtaining an accurate conception of the progress of society, he laid the foundation of the modern spirit of scientific historical research, but merely expressed, in literature, the sentiments which had been for a long time fermenting in the hearts and minds of the people.

The First Settlement of the Colonies.

The time and the method of the settlement of the United States were also fortunate for influencing the industrial advance of the country. The first settlement was not made by a roving army of pastoral people, with whom the arts were as yet undeveloped, or whose political and social relations had attained only to the patriarchal phase of development. The basis of their social life was political equality, and, though hardly yet aware of the importance of productive industry, still their history shows that all progress in civilization is dependent upon it.

In the history of the settlement of Massachusetts especially does this appear. The colony of Plymouth came over at their own expense, and the Massachusetts colony made their settlement also at their own charges.

Virginia.

With the settlement in Virginia, which was the first established in the country, in 1607, the case was somewhat different. The London Company, under whose auspices, and at whose expense, the colony at Jamestown was established, had been attracted to this country by the stories of the great wealth of gold which Spain had drawn from the new world. Yet they still contemplated the establishment of some other industry than searching for gold. Stith, in his *History of Virginia,* tells us that the company sent out in the second voyage, in the latter part of 1608, eight Poles and Germans, to make pitch, tar, glass, mills, and soap ashes, who, he observes, would have done well had the country been peopled, but in fact proved only a burden and hinderance to the rest. "No sooner were they landed but the president dispersed as many as were able, some to make glass, and others for pitch, tar, and soap ashes." "He himself carried thirty about five miles down the river to cut down trees, make clapboards, and lie in the woods. Among these were two fine and proper gentlemen of the last supply. These were at first strange diversions for men of pleasure. Yet they lodged, ate and drank, worked or played, only as the president himself did; and all things were carried on so pleasantly, that, within a week, they became masters, and thirty or forty of those voluntary gentlemen would have done more in a day than a hundred of the rest, who must be drove to it by compulsion."

Very soon, however, the attention of the colony was turned from all other pursuits to the raising of tobacco; and in 1617, Captain Argall, on his arrival as governor, found only five habitable houses in Jamestown, while the market-place, the streets, and all spare places were planted with tobacco. Various attempts were made to discourage the raising of tobacco, and further diversify the industries of the colony. The company made arrangements for sending out "husbandmen, gardeners, brewers, bakers, sawyers, carpenters, joyners, shipwrights, boatwrights, ploughwrights, millwrights, masons, turners, smiths of all sorts, coopers of all sorts, weavers, tanners, potters, fowlers, fish-hook makers, netmakers, shoemakers, ropemakers, tilemakers, edge-tool makers, brickmakers, bricklayers, dressers of hemp and flax, lime burners, lether-dressers, men skillful in vines, men for iron works, men skillful in mines," as appears in the original list, in *A Declaration of the State of Virginia*, published in 1620.

The character of these men appears also to have been considered, according to the same authority. "The men lately sent have been, most of them, choice men, borne and bred up to labor and industry; out of Devonshire about one hundred men brought up to husbandry; out of Warwickshire and Staffordshire above one hundred and ten; and out of Sussex about forty, all framed to iron-workes."

The culture of tobacco still, however, maintained its position as the chief industry, and in 1621 there were fifty-five thousand pounds exported to Holland. None was exported to England, on account of an impost which had been laid upon it there. At the end of twelve years from the settlement of the country, the company had expended £80,000, and were £4,000 in debt, while the colony numbered only six hundred persons, though much of this was unquestionably due to interference by the authorities with the natural growth of the industry of the colony. But, besides this, the colony itself had not the best conditions for its industrial development. Its political organization was still too aristocratic to develop fully the individual independence and energy which require the freedom of political equality for its best expression. Many of the colonists were criminals, sent over by the government of the mother country, which had commenced already to consider the colonies rather as a convenient receptacle for those whom she desired to free herself from, than as a nursery for the production of men and women who should display, in the freedom of their

conditions for social and moral development, the inherent tendency of mankind to progress with increasing knowledge gained by increasing experience.

From a tract entitled *A Perfect Description of Virginia,* which was published in 1649, and which can be found in Force's *Collection of Tracts,* the following extract serves to show the industrial advance which the colony had made up to that time. The writer states that 'they had three thousand sheep, six public brew-houses, but most brew their own beer, strong and good; that indigo began to be planted, and throve wonderfully well, from which their hopes are great to gain the trade of it from the Mogul's country, and to supply all Christendom; that the quantity of tobacco had so increased, that it had fallen in price to three pence a pound; that they produced much flax and hemp; and that an iron-work erected would be worth as much as a silver-mine; that they had four wind-mills and five water-mills to grind corn, besides many horse-mills; that a saw-mill was much wanted to saw boards, inasmuch as one mill driven by water will do as much as twenty sawyers; that they make tar and pitch, of which there was abundant material, as well as for pot and pearl ashes; that all kinds of tradesmen lived well there, and gained much by their labors and arts as turners, potters, coopers, to make all kinds of earthen and wooden vessels; sawyers, carpenters, tyle-makers, boatwrights, tailors, shoemakers, tanners, fishermen, and the like.'

From another pamphlet, written by Ed. Williams, and published in 1650, entitled *Virginia, more especially the Southern Part thereof, etc.,* the following extract will be read with interest. Speaking of the country, he says, "It will be to this commonwealth a standing magazine of wheat, rice, cole-seed, rape-seed, flax, cotton, salt, pot-ashes, sope-ashes, sugars, wines, silks, olives, etc." Of iron he says, "Neither does Virginia yield to any other province whatsoever in excellency and beauty of this oare; and I cannot promise to my self any other than extraordinary successe and gaine, if this noble and usefull staple be but vigorously followed." Concerning its textile fabrics he says, "For what concerns the Flax of China, that we may not lose the smallest circumstance of parallel with Virginia, Nature herselfe hath enriched this her bosome favourite with a voluntary plant, which by art, industry and transplantation may be multiplied and improved to a degree of as plentifull but more excellent nature, which because of its accession to the quality of silke wee entitle silke grass; of this Queen Eliz-

abeth had a substantial and rich peece of Grogaine made and presented to her. Of this Mr. Porey, in his discovery of the great river Chamonoak, to the south of James River, delivers a relation as of infinite quantity, covering the surface of a vast forest of pine trees, being sixty miles in length."

Though it must be remembered that many of the statements put forward in the numerous publications of that time concerning America are not to be too implicitly received, since they were written with the intention of stimulating emigration thither, and were consequently constructed very much as similar documents intended to produce similar results in the present day are written, yet they show that the process of the differentiation of industry commenced in Virginia, and bade fair to produce the same results as the more continuous, because unfettered, growth of the same process has produced in other parts of the country. The too general devotion to the culture of tobacco, as in late years the devotion of the south to the culture of cotton, checked, however, the diversity of employments, and thus prevented the country from becoming thickly settled enough to induce the attention to other pursuits which would naturally have arisen. Besides, too, the aristocratic cast of the social relations of the people, and the foolish prejudice against any other employment than agriculture, the planters arrogating to themselves the position of social leaders, and looking down ignorantly upon all labor as degrading, were shown even thus early, and had then an effect similar to that which they had later in the country's history. The climate and the richness of the soil, the cheapness of land and its abundance, enabled them to obtain large estates, and fostered the habit of considering the amount of the land one owned, rather than its being made productive, the test of gentility; while at the same time the comparative isolation of life thus produced led to a monotony of existence and a poverty of desires which made them satisfied with passing their lives confined to the small circle of interests directly surrounding them, and fostered that overweening self-pride which is the natural accompaniment of an existence devoid of an intelligent and comprehensive social sympathy.

In 1640 there were, on Christmas day, at the ports of Virginia, ten ships from London, two from Bristol, twelve from Holland, and seven from New England, while the number of the colony had reached twenty thousand. In 1705, Beverley, in his *History of Virginia,* speaks thus of the dependence of the colony upon other

nations to supply their wants, and of the change from the early habits of industry which he had before commended: "They have their clothing of all sorts from England, as linen, woollen, and silk, hats and leather. Yet flax and hemp grow nowhere in the world better than here. Their sheep yield good increase and bear good fleeces; but they shear them only to cool them. The mulberry tree, whose leaf is the proper food of the silk-worm, grows there like a weed, and silk-worms have been observed to thrive extremely and without any hazard. The very furs that their hats are made of perhaps go first from thence; and most of their hides lie and rot, or are made use of only for covering dry goods in a leaky house. Indeed, some few hides, with much ado, are tanned and made into servants' shoes, but at so careless a rate that the planters don't care to buy them if they can get others; and sometimes perhaps a better manager than ordinary will vouchsafe to make a a pair of breeches of a deer-skin. Nay, they are such abominable ill-husbands, that though their country be overrun with wood, yet they have all their wooden ware from England; their cabinets, chairs, tables, stools, chests, boxes, cart-wheels, and all other things, even so much as their bowls and birchen brooms — to the eternal reproach of their laziness."

Now that, with the nation's recent experience, it has been found that the test of a nation's social development is more accurately made by the condition of its industry than by that of its aristocracy, and that the interdependence of all classes binds society into one consistent whole, so that the body politic, like each of its members, is dependent for its well-being and vigor upon the healthy and unconstrained action of all of its organs, we can the more fully comprehend the reasons for the difference in the industrial advance shown in New England as compared with Virginia.

Massachusetts.

With the settlement of Massachusetts the natural advantages of the soil and climate appeared, when compared with those in Virginia, to be greatly in favor of the latter. A generally barren and rocky soil, with tolerably fertile valleys scattered here and there along the river courses; an inclement climate, subject to repeated and sudden fluctuations, which, with the hardships incidental to the unprovided condition of the colony, proved fatal to so many of them during their first winter. But to these very causes the industrial success of New England is largely due. The

very sterility of the soil forced their attention to making use of the timber which it provided, and soon the fisheries furnished by the waters of the coast became also an important branch of their industry.

At the time of the settlement of Massachusetts, timber had already become somewhat scarce in England, since the use of coal in making iron had not been discovered, and the forests had been wasted in the iron manufacture, which had already begun to be an important branch of English industry. In 1623 the "Anne," a ship of one hundred and forty tons, was loaded at Plymouth for England with a cargo of clapboards, and a few beaver and other skins. This was the commencement of a business which soon increased so as to become a most important interest with the colonies. Not only was lumber largely shipped to England, but the settlement of the West India Islands depended chiefly upon New England for their supplies of barrels and boxes, in which to export their crops of sugar and molasses.

Ship-building in the Colonies.

Ship-building was also soon established in New England. The first vessel ever constructed in North America by Europeans was a "Dutch yacht," called the "Onrest," built by Captain Adriaen Block, in 1614, at Manhattan River. She was of sixteen tons burden, with thirty-eight feet keel, forty-four and a half feet in length, and eleven and a half feet wide. In her, Captain Hendrickson, in the summer of 1616, discovered the Schuylkill River, and explored nearly the entire coast from Nova Scotia to the Capes of Virginia.

In 1614 Captain John Smith set sail from England for Virginia, with two ships. His purpose was to engage in mining for gold and copper. Having reached the coast of Maine, he made several unsuccessful attempts at whale fishing, and landing, built seven boats, with which the crew were very successful in cod-fishing. Thus the commencement of our fisheries was made in American built bottoms.

At Plymouth, in 1642, there arrived a carpenter and a salt-maker, who had been sent out by the company. Governor Bradford, in his *History*, speaks thus of the former: "He quickly builds two very good and strong shallops, with a great and strong lighter, and had hewn timber for ketches, but this spoilt; for in the heat of the season, he falls into a fever and dies, to our great loss and sorrow."

The salt-maker attempted unsuccessfully to make salt both at Cape Ann and at Cape Cod. In 1641 a bark was built by subscription at Sandwich, near Cape Cod. She was about fifty tons burden, and cost two hundred pounds. The money for her construction was advanced by various persons, who formed a sort of joint stock company.

The Massachusetts colony built their first vessel at Medford. She was launched on the fourth of July, 1631, and christened by Governor Winthrop, to whom she belonged, "The Blessing of the Bay." The unsettled condition of things in England, produced by the commencement of the civil wars of the commonwealth, reacted upon the colony. Their industry had not yet become entirely remunerative, and they still depended upon importations for a portion of their supplies, and for the accession to their ranks of fresh emigrants. Governor Winthrop, in his *Journal,* writes of the new aspect induced by this juncture of affairs as follows: "The general fear of want of foreign commodities, now our money was gone, and that things were like to go well in England, set us on working to provide shipping of our own, for which end Mr. Peter, being a man of very public spirit and singular activity for all occasions, procured some to join for building a ship at Salem of three hundred tons, and the inhabitants of Boston, stirred up by his example, set upon the building of another at Boston of one hundred and fifty tons. The work was hard to accomplish for want of money, etc.; but our shipwrights were content to take such pay as the country could make."

The want of money in the colony was shown at this time by the fact that corn was made a legal tender for debts.

Other Industries.

In other departments of industry we shall find the colonists actuated by the same restless and persistent spirit of enterprise. From the first, though agriculture, or the raising of the food they needed, was considered, as it should be, the art of primal necessity, yet they were constantly extending their efforts in every direction, as though they were conscious that a high condition of civilization is attainable only by the most highly diversified employments, and that the general culture of society, like that of the individuals composing it, can be reached only by the widest and most active exercise of all of its numerous functions; while at the same time respecting every kind of industry, they considered them all as of

importance, and avoided the ignorant feeling of contempt for any useful occupation.

The art of ship-building, of which we have noticed the beginning, spread rapidly through all the seaboard of the New England and the Middle States, bringing the young nation into intimate commercial relations with the rest of the world, and by spreading everywhere a knowledge of the comparative freedom of their political relations, stimulated the emigration to the country which has done so much for our subsequent advance, and has been so instrumental in breaking down the narrow bounds of prejudice, and generating a broad and human interest in life in the place of a petty isolation and contempt of foreign nations.

It was estimated at the beginning of the war of the Revolution that three hundred and ninety-eight thousand tons of colonial-built shipping were employed in the general commerce of Great Britain, or nearly one-third, and if the West India trade was included, nearly two-thirds.

House-building.

Perhaps, however, the most important branch of industry is that of house-building, as serving to indicate the advancing civilization of a nation, and the excess gained by their industry over the bare necessities of living. Peculiarly is this so in America, where labor is not generally consigned to hovels, especially in agricultural districts, in order that its earnings should be squandered upon a palace for the gratification of some ruler's or capitalist's love of vain display. As we have seen, the first cargo shipped from Plymouth consisted chiefly of clapboards.

The forests of the United States afforded an abundant supply of building material. The logs at first were sawed or split into the required form by hand; and the time necessarily consumed in this operation made it very expensive. The saw-mill is said to have been first introduced into Massachusetts in 1633, which was some years before it was used in England. Even as late as 1767 a saw-mill was destroyed in that country by the mob, because it was supposed to be destructive to the work of the sawyers.

At the time of the settlement of this country, the hand process was the only one used in England for the preparation of lumber, and the colonies must have brought over with them persons who were acquainted with its methods. As we have seen, the use of machinery was soon introduced, though as late as 1663 England

depended chiefly upon Holland for its sawn lumber. With the introduction of the saw-mill, the energy of the numerous streams in New England was soon applied to the preparation of lumber, and the same process of improvement in house-building began, which may be seen at work in the outskirts of our civilization, where the advent of the saw-mill abolishes the use of the log cabin.

Saw-mills and Machinery.

In the "Body of Liberties," which was a system of laws adopted by the General Court of Massachusetts in 1641, it was provided that there "should be no monopolies but of such new inventions as were profitable to the country, and that for a short time only." Under this provision a saw-mill was built in Scituate in 1656, for which the authorities stipulated, as appears in the *Massachusetts Historical Collections*, "that in case any of the townsmen do bring any timber into the mill to be sawed, the owners of the mill shall saw it, whether it be for boards or plank, before they saw any of their own timber; and they are to have the one half for sawing the other half. And in case any man of the town that doth bring any timber to the mill to be sawed shall want any boards for his particular use, the owners of the mill shall sell him boards for his own use, so many as he shall need, for the country pay at 3*s.* 6*d.* an hundred inch sawn; but in case the men of the town do not supply the mill with timber to keep it at work, the owners of the mill shall have liberty to make use of any timber upon the Common to saw for their benefit."

Wind saw-mills were erected by the Dutch in New York as early as 1633, and were also used there for grinding-mills. One of the first saw-mills built there was on Governor's Island, in the harbor of New York city. In 1639 it was leased for five hundred merchantable boards, yearly, half oak and half pine. The introduction of the saw-mill was a great improvement. Before that time, the first houses in the colony were hardly better than the wigwams of the Indians, and unquestionably the first shelters constructed were fashioned upon such models. Then came the log hut, described by the poet as

> "A rude habitation,
> Solid, substantial, of timber rough-hewn from the firs of the forest;
> Wooden-barred was the door, and the roof was covered with rushes;
> Latticed the windows were, and the window panes were of paper,
> Oiled to admit the light, while wind and rain were excluded."

Brick Making.

The materials for some of the best houses, especially those for the official residences of the governors and other dignitaries, were at first imported from England or from Holland; but soon the art of brick making was learned, and with lime made from oyster-shells, before the deposits of limestone were found, substantial brick houses came into use. The first brick-kiln in New England of which there is any account, was set up in Salem, Mass., in 1629. From the *Massachusetts Historical Collections*, the following notice of it is taken, written by the minister of the town: "It is thought here is good clay to make Bricke, and Tyles and Earthen pots, as need be. For stone, here is plentie of slates at the Isle of Slates, in Massathuletts Bay, and Lime-stone, Free-stone, and smooth stone and Iron-stone, and marble stone, also in such store that we have great Rockes of it, and a harbor hard by. Our plantation is from thence called Marble Harbor."

At first, the use of wood in building houses was so entire, that even the chimneys were made of this material, coated with clay. Such chimneys were called "catted," and the danger from fire thus incurred was heightened by the common practice of making the roofs thatched. In the first year of the settlement of Jamestown, in Virginia, the fort, the store-house, and all the supplies it contained, together with most of the rest of the town, were burnt by a fire which originated in this way. The same fate, from the same cause, befell the first building and store-house built by the Pilgrims at Plymouth, within a month of its being finished. In Boston, the first fire, which took place in 1641, and destroyed two buildings, commenced from one of these imperfectly built chimneys, from which the flames were communicated to the thatch of the roof. The use of such chimneys and roofs was therefore forbidden by Governor Dudley.

In 1635, the new fort at New York, Fort Amsterdam, which had cost the labor of two years in building, caught fire from the same cause, and was destroyed. In consequence, their use was prohibited there. Throughout the country, however, the isolation of the houses, and the difficulty of transportation, made brick so scarce that these methods of building continued long in use; and in 1789, Washington, in his tour through the Eastern States, noticed several times in his diary the fact, which seems to have struck him as worthy of record, that after leaving New

York, no dwelling-houses were seen in the villages or small towns through which he passed, which had not brick or stone chimneys. Those in Connecticut had generally "two flush stories, with a very good show of sash, and glass windows." The last ten thousand bricks which were imported into Boston from England in 1629, were intended for use in building chimneys.

In Boston, the first brick house, which was also, most probably, the first one in Massachusetts, is said to have been built in 1638 by a Mr. Coddington. In 1643 a watch-house of brick was built in Plymouth, the bricks for it being furnished by a Mr. Grimes, at eleven shillings a thousand.

In 1630, at the first Court of Assistants, held in Charlestown, Mass., the wages of carpenters, joiners, bricklayers, sawyers, and thatchers were fixed at two shillings a day, with a penalty of ten shillings to both giver and taker if more was paid. This was one of the few instances of an attempt to transplant to the colonies the foolish interference by legislation with the wages of labor, which prevailed even much later in the mother country. The folly of attempting to introduce into the freer political and social conditions of the colony this practice, inherited from the times when the chief business of the rulers was supposed to be the domination of industry, was soon seen, and in 1640 all such restrictions were removed.

In 1692 an order of the General Court required all buildings of a certain size to be built of stone or brick, and to be roofed with slate or tiles, on account of the "great desolations and ruins" which had been caused by crowding together houses of wood. In 1700 Boston contained about one thousand houses and ten thousand people.

In New York bricks were early imported from Holland, and the style of the houses was an imitation of those of Amsterdam. Brick-making was introduced by the last governor Stuyvesant. In 1649 a deputation was sent to the Hague to complain of his administration to the company, the chief charge brought against him being that he had been mostly engaged in building, brick-making, and such like occupations, though they were unprofitable. At this time, the chief industry of the colony was the gathering and exportation of furs and skins. At the Van Rensselaer estate, below Albany, bricks were made before they were at New York, and between 1630 and 1646, as appears from the accounts, were sold for fifteen florins the thousand. Earthen ware, which was

said to equal that made at Delft, was early manufactured on Long Island, and the company in Holland, as appears from the records, refused to grant special privileges or monopolies for the encouragement of new branches of industry. Their language in so doing was as follows: "The grants we not only entirely disapprove, but require that you will not give one single grant more hereafter, as it is, in our opinion, a very pernicious management, principally in a new and budding state, whose population and welfare cannot be promoted but through general benefits and privileges, in which every one who might be inclined to settle in such a country, either as a merchant or mechanic, may participate."

In 1678, Governor Andros, in a report to the committee of the House of Lords on the colonies, stated that New York city contained three hundred and forty-three houses, with ten inhabitants to each house, "most wood, some, lately, stone and brick, good country houses, and strong of their several kindes." About the end of the seventeenth century, Madam Knight thus describes the buildings of New York: "The buildings are brick generally, in some houses of divers colors, and laid in cheques; being glazed, they look very well." Of their interiors she says, they are "neat to admiration;" that the fireplaces had no jambs, but were made flush with the walls, while the fireplaces were built of tiles, and extended into the rooms sometimes as much as five feet. In a few of the streets, narrow brick sidewalks were laid down.

The prices of building materials are thus given for 1637, in New Amsterdam, in *O'Callaghan's New Netherlands*: Bricks, ten florins ($4) a thousand; rushes, or reeds for thatching, one and a half florins for one hundred bundles, or, at Fort Orange, one florin. The daily wages of carpenters were about two florins, and day laborers, one florin. Nails were eight to ten stivers (16 to 20 cents) a pound, a pound containing a hundred nails. For the minister at Rensselaerwick, a dwelling-house, built entirely of oak, with doors and window casings of the same, was purchased for three hundred and fifty guilders.

The Various Styles of Domestic Architecture.

The Dutch style of house-building prevailed also at Albany, and gave rise also to the fashion of the houses in the northern portion of New Jersey; the gable walls of brick, and, later, of stone, while the other walls were of wood, and the roofs of shingles.

In 1684, the letters of Gawen Laurie describe the houses of the poorer classes in East New Jersey as quite primitive in their construction, being made of split trees, set up on end, and the other end nailed to the "rising;" they were then covered with shingles, and plastered inside. The cost was about five pounds each, and barns were built in the same manner. "We have good brick earth," he writes, "and stone for building at Amboy, and elsewhere. The country farm-houses they build very cheap; a carpenter, with a man's own servants, builds the house; they have all the materials for nothing, save nails. The chimneys are stone."

At the beginning of this century, the house was still standing at New Castle, Pennsylvania, in which Governor Lovelace entertained George Fox in 1672. It was built of brick and hewn timber, the mortar and cement having been made from oyster shells. In Pennsylvania and Delaware, the first buildings erected by the Swedes, who settled that portion of the country, were modelled after the houses in use at that time in the northern part of Europe, from whence the colonists came. They were built chiefly of wood, were rudely finished, consisted only of one story, containing only a single room, and having low doors, while the windows were mere apertures in the walls. The Dutch, who succeeded them, brought bricks from New York.

The manor house built by William Penn, the founder of Pennsylvania, at Pennsbury, a few miles above Bristol, in Bucks County, was constructed of bricks, which were chiefly brought over from England. This house cost its owner over five thousand pounds.

In the Southern States, wood was the material chiefly used in domestic architecture. As late as 1791, General Washington describes Charleston as having a number of very good houses built of brick and wood, though the majority were of the latter material.

In 1790, Hamilton, in his report as Secretary of the Treasury, speaks of the manufacture of bricks, tiles, and potter's ware, as among the most important branches of the national industry. From the period of the independence of the country until quite into this century, the style and manner of house building expressed the growing wealth and culture of society; while the differences in the domestic architecture of New England, the Middle States, and the South, necessitated by the differences of the climate, were also suggestive of the differences in the social relations of their various inhabitants.

Here, as elsewhere, the differences in the political constitution of the various colonies were also expressed. The democratic constitution of New England society produced a more general and uniform air of comfort in the houses. Few had any pretension to be splendid, but all had an air of comfort. The proprietary governments, and the more aristocratically constituted society of the Southern States, gave rise to a greater difference in the houses of the different classes, and mansions with considerable pretensions to architectural effects were more common, and more striking from their contrast with the poorer accommodations afforded to industry.

With the opening of the West, the new methods of transportation, the use of steam, and the application of machinery to lessening the expenditure of labor, domestic architecture has partaken fully of the new spirit of the age, and solidly-built cities now spring up along the lines of travel through the West almost as rapidly as though through the agency of the wonder-working lamp of Aladdin.

Improvements in House Building.

With the application of machinery, the labor of house building has been greatly lessened, and the western prairies are dotted over with houses which have been shipped there all made, and the various pieces numbered, so that they could be put up complete, by any one. The use of iron also in domestic architecture has been one of the chief improvements of modern times, especially in our cities; and though our architects have not yet arrived at an artistic method of treatment of this material, still its use will increase with time. The strength of iron is textile, while that of stone is in supporting a direct thrust, and our architects as yet not recognizing this distinction, have used iron as though it was stone, notwithstanding that, in the various crystal palaces, examples have been given of the correct method for its treatment.

The method of construction with wood, known as "balloon framing," is also the most important contribution to our domestic architecture which the spirit of economy, and a scientific adaptation of means to ends, have given the modern world. When it was first used is not known with any definiteness, but it has, within the last fifty years, entirely replaced the old method of construction. The heavy beams, the laborious framing, the use of mortises and tenons, have all been replaced by lightness and constructive skill, so that a single man and a boy can put up a

house, such as formerly, for its "raising," required the combined force of a village.

There is hardly a better evidence of the American spirit, which is so prompt to adapt itself by new methods to new conditions, than the introduction of this new style of building, and it has really been the most efficient cause of the rapidity with which, in modern times, our villages and towns spring into existence. Our methods of construction, like our means of transportation, have passed into the railroad phase of development.

Agriculture in the Colonies.

With the settlement of the various colonies, agriculture was of course considered as the first and most important branch of industry. The colonies brought over with them supplies of food sufficient to last for some time, and in many cases were forced to depend upon other countries for their renewal for a year or two. With the commencement of agriculture was of necessity allied the raising of stock, and the differentiation of industry which naturally follows from manufacturing the various articles of clothing from the materials thus provided.

The first cattle ever brought to America are said to have been introduced by Columbus in his second voyage in 1493. In 1553 cattle were carried by the Portuguese to Nova Scotia and Newfoundland, and are said to have increased there very rapidly. In 1565 cattle, horses, sheep, and swine were carried to Florida by the French, and in 1608 the same people introduced cattle into Canada.

The first permanent settlement in Virginia was, in the year 1609, in possession of between five and six hundred hogs, with as many fowls, a few goats, and some sheep and horses. The scarcity of food, however, led to their extinction by the colonists, and in 1610 another stock of cattle was brought from the West Indies, and the penalty of death for killing them was enacted.

The next year, Sir Thomas Gates brought with him three hundred emigrants, over one hundred cows, some swine, and an ample store of provisions. In 1620 the cattle had increased to about five hundred, and in *A Declaration of the State of Virginia*, are described as being "much bigger of body than the breed from which they came; the horses also more beautiful, and fuller of courage."

In 1649 the cattle of Virginia, including bulls, cows and calves,

were estimated at twenty thousand, together with two hundred horses, three thousand sheep, five thousand goats, and many swine. Of these many were exported to New England, where the diversities of industry made them more valuable.

In the Plymouth Colony the first neat cattle were introduced by Edward Winslow, in the spring of 1624, and consisted of three heifers and a bull. In 1626 twelve cows were sent to Cape Ann, and in 1629 thirty more. With the settlement of Massachusetts in 1629, there were sent out one hundred and forty head of cattle, with some horses and goats. With Governor Winthrop, in the following year, three hundred kine, and a number of other animals had been shipped, but more than half of them died on the passage, or during the first winter. The Indians were also very destructive to the animals of the colony, as were also the wolves. Yet the increase of their stocks was rapid, and Bradford, the second governor, in his recently discovered *History of Plymouth,* says that by this, and the rise in provisions from the increasing emigration, "many were much enriched, and comodities grew plentifull; and yet in other regards this benefite turned to their hurte, and this accession of strength to their weakness. For now their stocks increased, and ye increase vendible, ther was no longer any holding them together, but now they must of necessitie goe to their great lots; they could not otherwise keep their katle, and having oxen growne, they must have land for plowing and tillage. And no man thought he could live except he had catle and a great deale of ground to keep them, all striving to increase their stocks."

The Differentiation of Industry.

In 1651, Johnson, in his *Wonder-working Providence,* thus speaks of the industries of the colony: "All other trades have here fallen into their ranks and places, to their great advantage; especially coopers and shoemakers, who had either of them a corporation granted, enriching themselves by their trades very much. As for tanners and shoemakers, it being naturalized in these occupations to have a higher reach in managing their manifactures than other men in New England, and having not changed their nature in this, between them both they have kept men to their stander hitherto, almost doubling the price of their commodities according to the rate they were sold for in England, and yet the plenty of leather is beyond what they had there, counting the number of the people; but the transportation of boots and shoes into forraign parts hath

vented all, however." He mentions also among others who had "orderly turned to their trades," card-makers, glovers, fell-mongers, furriers. "As for tailors, they have not come behind the former, their advantage being in the nurture of new fashions all one with England." And some "have a mystery beyond others, as have the vinters."

In 1677 the Assembly of the United Colonies of Connecticut, at Hartford, ordered that no tanner should receive more for tanning than two pence a pound for green, and four pence for dry hides; and that they should be sold for three pence a pound for green, and six pence for dry hides, and so marked that they could be readily known. Shoemakers were also to charge five and a half pence a size "for all playne and wooden-heeled shoes above men's sevens. Three-soled shoes, well-made and wrought, not above seven and a half pence a size for well-wrought French-falls."

In New York, domestic cattle were imported from Holland by the West India Company in 1625, by Pieter Evertsen Hulst. He sent one hundred and three animals, horses, cows, hogs, and sheep. In 1627 a cow was worth there £30, and a yoke of oxen £40. In 1650 the company supplied each tenant with land, house, tools, four cows, as many horses and other animals, to be returned in six years. A cow and a calf were then worth £40.

New Jersey was provided with cattle from New York, and their increase soon made this province one of the storehouses for the supply of the cities of Philadelphia and New York. In Pennsylvania the Swedes were, in 1627, supplied with neat cattle by the Swedish West India Company, and the colonists for a long time wore moccasins, and vests and breeches of Indian-dressed skins. Even the women wore jerkins and petticoats of the same material, and their beds, except the sheets, were also of leather. Flax, hemp, and wool were also spun by the women.

In the private accounts of William Penn, a pair of leather overalls are charged at £1 2*s*., and a painted skin at twelve shillings. An account of the province, written in 1697, states that twenty bullocks, besides many sheep, calves, and hogs, were killed every week for the supply of Philadelphia. A cow could be bought for £3, and salted pork and leaf were regularly exported. Raw hides were three halfpence a pound. Curriers received 3*s*. 4*d*. a hide for dressing, and paid 20*d*. a gallon for their oil. Shoemakers were paid two shillings a pair for men's and women's shoes, while last-makers received ten shillings a dozen for their lasts, and heel-

makers two shillings a dozen for heels, which were most probably of wood. Among the trades enumerated were tanners, skinners, glovers, pattern-makers, saddlers, collar-makers, book-binders, and carriage-makers.

In the Southern Provinces, the differentiation of labor was a slower process than in the more enterprising Eastern States. The cattle were left to provide principally for themselves. In the account written by Mr. Perry, in 1731, he states that cattle were numerous, but that there was not a hovel in all the country for their shelter, and that, in consequence, ten thousand horned cattle died from exposure during the previous winter. The planters did not know how to mow or to provide fodder. Butter was 7*s*. 6*d*. a pound, and the winter before, 12*s*. The hides were exported raw, or thrown away. Imported shoes were sold at 10*s*. a pair, and ox hides at 20*s*. each. "Neither are they destitute of the means to tan them, for they make very good lime with oyster shells, and the bark of oak trees is so plentiful that it costs but the trouble of gathering. They want, therefore, only a sufficient number of good tanners and shoemakers. I might say the same of leather-dressers, since they send every year to England alone 200,000 deer-skins undrest. Yet Carolina produces oker naturally, and good Fish oyle may be had from New York or New England very cheap, so that they might be drest and made up into Breeches in the country; for which these skins are very proper, being warm in winter and cool in summer."

The Extension of the Settlements.

From these settlements upon the coast, the population gradually extended inland, following generally the course of the rivers, and carrying their agricultural pursuits into the valleys.

In many of the various articles of this work upon the position of the special industries, the history of their foundation and growth will be found more in detail. One of the great obstacles in the way of the more rapid increase of the country was the bad state of the roads, and the necessarily slow condition of the intercommunication. It was not until the discovery of the use of steam, and its application to railroads, that civilization in any country had the means at its disposal for the circulation of its men or its products, with the certainty or rapidity which are absolutely necessary for the fullest development of its resources.

Methods of Communication.

Up to this time the improvement in the modes of communication underwent the same gradual course which has marked elsewhere the passage of society to its present phase of organization. About the centres of population the roads were improved. Stages were introduced, canals came into use, and the isolation of small communities began to give way before larger national sympathies and more extended interests.

The war of the revolution had much to do with introducing and organizing a national spirit among the colonies. In the armies, the men from different sections met each other, and learned to supplant their sectional jealousies with a mutual respect and a wider conception of a national destiny. With the formation of a national Congress, the necessity for a more intimate union of the states than that of the confederation became evident, and the means were prepared for supplanting the various political differences in the organizations of the proprietary and southern colonies by constitutions which more nearly approximated the republican character of those in New England. This course of action, which supplemented the results of independence gained by the revolution, though more concealed in its workings, was quite as influential as was the war in producing a distinctive national feeling.

With the result of the late war, the abolition of slavery, and the unification of the financial policy of the states, another great step has been taken towards the advancing organization of the social forces of the country. Labor has been made free from degradation, and the obstacle of slavery cleared away from the social and industrial advance of every one.

With political equality, the means of education open freely to all, the guarantee of republican institutions in every state, with no legislative or other artificial impediments in the way of any one to improve his position, but with every avenue of industry open to all, and only individual fitness made the test of success, the United States now offers to the industry of the world, for the first time in the history of human progress, the opportunity for it to enjoy the most perfect freedom of development, and to take its proper place in the organization of liberty. With the use of the ballot, industry has secured the ability to peacefully obtain its rights, for which, in Europe, revolutions are still necessary. With the

means of free education, the power to comprehend those rights is afforded to every one. With no restraint upon the freedom of every man to seek the spot where he can find the best opportunity for exercising his industry; with the wide expanse of the national domain open before him, and no custom-house or other governmental restriction to prevent his going wherever he may wish, industry, for the first time in its history, has the ability to control the selection of its own conditions, and organize them in accordance with the demands of its increasing knowledge.

The Activity of National Life.

The political life and activity of a nation, like that of each individual, consist in the continuous adjustment of internal to external conditions, in this cycle of continuous motion and change which constitute the phenomena of the moral as of the physical world.

Though it may not be at present possible to foresee with minuteness what is in store for us in the future, yet from a comparison of the immediate past, we can measurably prefigure the result. From the small beginnings which have here been rapidly sketched, with their simple uniformity of employments, we have seen produced, in less than three hundred years, the great diversity of our present occupations, and the differentiation of our industrial pursuits, of which this work will give an idea.

With the increasing circle of employments for human energy, the forces brought to bear upon the question of social progress have increased in both number and intensity, and the solution of the problem, like that of the resolution of various forces in mechanics, has become more complex. Yet the result is in the line of progress, in the direction of securing to each individual the largest liberty for his personal endeavors, and for society at large the greatest amount of material for its collective comfort and well-being.

Upon the next century of our national life, we start from a point which has been reached by the labors of two centuries, and with the collected experience of the generations which have preceded us, with the organized appliances which their labors have prepared for us, to carry forward still further the process of industrial development, and afford in our turn the evidence that the moral progress of mankind is best secured by liberty.

SEWING MACHINES.

AN AMERICAN INVENTION. — AN EVIDENCE OF THE SPIRIT OF MODERN TIMES. — INVENTIONS PREVIOUS TO THE SEWING MACHINE. — THEIR VALUE AS STEPS TOWARDS IT. — THE FIRST PATENT. — HOWE'S PATENT. — THE NUMBER OF PATENTS ISSUED. — CLASSIFICATION OF SEWING MACHINES. — THE VERDICT OF THE PARIS EXPOSITION OF 1867. — THE COMMITTEE OF THE AMERICAN INSTITUTE; OF THE MARYLAND INSTITUTE. — THE POINTS WHICH THE MANUFACTURERS NOW SEEK TO REACH IN SEWING MACHINES. — THE G. F. MACHINE. — ITS DESIGNER. — THE POINTS OF ITS SUPERIORITY. — A DESCRIPTION OF THE METHOD OF ITS CONSTRUCTION. — THE EFFECT OF ORGANIZATION UPON THE MANUFACTURE OF SEWING MACHINES. — THEIR PRESENT PRICES COMPARED WITH THOSE OF THIRTY YEARS AGO. — THE SOCIAL EFFECTS OF THE SEWING MACHINE.

THE introduction of the sewing machine, by which the slow and tedious process of hand sewing is so largely done away with, is due entirely to American ingenuity and enterprise. Such an application of the modern spirit of industry, which seeks in every way to dignify labor by lifting it above the plane of drudgery, and by introducing the necessity for brains, as well as simple muscular force, into all the operations of industry, tends to make the operative more of a human being, exercising in his business of life more of the faculties which form the distinctive characteristic of man in the hierarchy of nature, and is analogous to the political equality which underlies the theory of our government, and which seeks to make of any individual of the body politic a citizen, conscious of the responsibilities of such a position, instead of a subject dependent upon others for a knowledge of his duties or his rights.

The steps which, before the completion of a practically working machine, were made in this general direction, will be seen to have been only such as in no way detract from the claim of America to have originated and perfected this industrial appliance. The ultimate effects of the sewing machine, though by no means yet fully attained, are still already sufficiently manifest to justify the assertion that this invention ranks among the foremost of this century.

The earliest patent which appears to have been granted for a machine to improve or facilitate the process of sewing, was granted in England, on the 24th of July, 1755, to Charles F. Weisenthal, for an improved method of embroidering. Under this patent he claimed a needle, pointed at both ends, and having the eye in the middle, so that it could be passed both ways through the cloth without being turned round. The next patent was granted to Robert Alsop, in 1770, for the use of two or more shuttles in embroidery, their purpose being to secure the stitches. In 1804 John Duncan took out a patent for an improved process by the use of barbed or hooked needles, by which the loops were made and secured somewhat as the stitch is made in the single-thread sewing machine. In 1807 James Winter patented in England an appliance for sewing leather gloves, the importance of which here arises only from the fact that the material was held in position by metallic jaws, thus leaving the operator's hands free. On July 17, 1830, a French patent was granted to M. Thimonier for a machine to do crochet work, which could also be applied to sewing. In this machine a hooked needle was used. In 1848 this machine was improved by M. Maguin, a partner of the inventor, and in 1851 was exhibited in the great London World's Fair of that date. None of these machines, however, were intended really for the purpose which the sewing machine performs, and are mentioned here simply because each of them in turn was a partial step in the use of some mechanical process, which was afterwards introduced in the sewing machine.

In the Patent Office at Washington is the model of a "machine to sew a straight seam," which was patented February 21, 1842, by James Greenough, of Washington. This machine made what is known as the "shoemaker's stitch." The needle was made with the eye in the centre, and pointed at both ends, being pushed through and then drawn back by means of pinchers. In 1843 other patents were granted to G. R. Corliss and B. W. Bean. Bean's machine worked by crimping the material, by running it through corrugated rollers, and then sewed by thrusting a needle through the folds, thus, in fact, basting it. Another machine was patented in 1844, by Rogers. The next year, 1846, Elias Howe, Jr., patented his, on September 10. This was the first practicable machine for sewing.

Though not patented until this year, Mr. Howe had invented the machine some years before, and working without the knowl-

edge of what had been done before by others, he had used some devices which others had used, but had so combined them in novel shapes or arrangements that the machine, as a whole, was entirely his own invention. His patent claims, substantially, the use of a needle with the eye in the point, and a shuttle for the purpose of uniting two edges in a seam, or their equivalent, making the stitch by interlocking two threads. He improved his machine as originally invented, but failed in exciting sufficient attention to it, either in the United States or in England, to raise the capital necessary for its successful introduction into popular use. His attempts to do this exhausted his means, and reduced him to great poverty.

Though he afterwards received very large amounts of money from the subsequent inventors, who manufactured their machines under a royalty to him for the use of the appliances governed by his patent, yet the heavy expenses of the lawsuits he was forced to undertake to enforce his claims absorbed so much of the money he received that he died in comparative poverty.

While Howe was attempting to introduce his machine to notice, the attention of inventors began to be turned to the subject of sewing machines, and patents for improvements, modifications, or new arrangements of the parts began to flow in a steady stream from the Patent Office. Between the year when Howe's patent was issued to the year 1871 nearly one thousand different patents relating to sewing machines have been issued, and as many applications for patents have been rejected. Of this number thirty-seven were issued in 1857, seventy-two in each of the two succeeding years, and with an average of nearly fifty for each year until 1869, when eighty-eight patents were issued, being the largest number in any single year up to that date.

Of all these patents, of course the large majority have never been carried so far as the production of machines for popular use, while many of them were simply for modification and improvements upon the mechanical devices already in use, or for new combinations of them. At present, therefore, all the sewing machines presented before the public may be classed, according to the variety of stitch they make, into three classes.

The first are those sewing machines which make the lock-stitch, using two threads, and consequently a shuttle. The use of this kind of stitch consumes about two and a half yards of thread in sewing a seam a yard long.

The next kind of stitch is the loop or double-chain stitch, which consumes about six yards of thread in sewing a seam a yard in length.

The third class is the chain-stitch, or the twisted loop-stitch, which is made with a single thread, and consumes about four yards of thread in sewing a seam a yard in length.

In the Paris Exposition of 1867 there were numerous machines exhibited which made the loop or the chain-stitch, but not one of them was noticed by the international juries as deserving of mention for any special merit.

The classification of sewing machines, made by a committee appointed by the American Institute of New York for the purpose of examining their comparative merits, was as follows: —

The committee divided them into four classes, ranging them in the order of their merits. The first class included the *shuttle* or *lock-stitch* machines, made for family use, and the committee assigned this position to machines of this kind on account of the "elasticity, permanence, beauty, and general desirableness of the stitching when done," and also for the wide range of its application.

The second class made by the committee embraced the *shuttle* or *lock-stitch* machines, intended for manufacturing purposes.

The third class included the *double chain-stitch*, while the fourth class included the *single thread, tambour*, or *chain-stitch* machines.

Of the first and second class, the Weed, the Howe, the Singer, the Wheeler and Wilson, the Florence, and others are the chief representatives. Of the third class, the Grover and Baker is the chief representative. Of these, while the committee acknowledged that this stitch can be used most successfully for embroidery purposes, yet they objected to it from the fact that it consumes so much more thread than the others, and leaves a ridge projecting upon one side of the seam, which makes it unfit for many garments.

In the fourth class the Willcox and Gibbs is the chief representative. With these machines the committee considered that the tendency of the stitch to ravel formed so serious an objection that they refused to recommend it for a premium.

Of the various machines, therefore, the question of the best becomes narrowed down to the consideration as to which of those making the lock-stitch has the most special claims to consideration. Not only does the verdict of the judges maintain this, but it would

seem to be also the judgment of the public, who, as consumers, are practically interested in deciding between the adverse claims put forward by the various machines offered for their acceptance. This becomes evident when it is remembered that at least five-sixths of the machines manufactured and used in the world are machines which make the lock-stitch.

Machines making the lock-stitch are all good machines, and have been practically tested by so many thousands that it would be absurd to deny that they do their work well. The claim of any one of them to being superior to the others must depend upon certain technical points in which it is superior to the others. By a careful comparison of these machines, it is evident that the Weed machine, which obtained the highest prize at the Paris Exposition of 1867, was then rightly judged, and is to-day, for family use, the best there is.

Nor, after a careful consideration of the following points, can any one without prejudice fail to come to the same opinion. In the first place it is the simplest in its construction; it has a straight needle; it will readily stitch either thick or thin material; the upper and lower thread have the same tension — a most important point; it will work as well with both threads of the same thickness; its needle can be set without the use of a screw-driver, or any other tool; the needle is moved perpendicularly, instead of at the end of an arm, by which it is moved through the segment of a circle. This is an important point, since the differences of the atmosphere affect the length of the arm, so that to this cause the best judges assign the singular "fits" which so often affect sewing machines when they refuse to work correctly. Its machinery is below the table, where it is free from dust. It is so well balanced that it is worked both easily and noiselessly. These points and others of less importance were allowed, in the Maryland Institute, in 1869, to constitute the superiority of the Weed machine over its competitors, and to entitle it to the highest premium.

Now that the sewing machine is so popularly accepted, and the demand has risen to such proportions that to supply it requires a production of nearly two thousand machines a day, or over six hundred thousand a year, the best mechanical ingenuity in the country finds in it a most profitable field for employment, and the workmanship displayed in the machines from the best manufacturers is exquisitely perfect.

It is no longer a question concerning the practicability of sew-

ing by machinery, but the efforts of the various manufacturers are devoted to producing machines which shall sew most noiselessly; which shall be so accurately fitted, and so evenly hung, that they can be worked with the least expenditure of force; while the simplicity of their mechanism and its accuracy shall make them, under use, more durable and more easily kept in order.

As an interesting evidence of the success attained in perfecting the sewing machine in these important points, we would mention here a new machine introduced by the Weed Company under the trademark of G. F., or "General Favorite," as these initials are ordinarily translated.

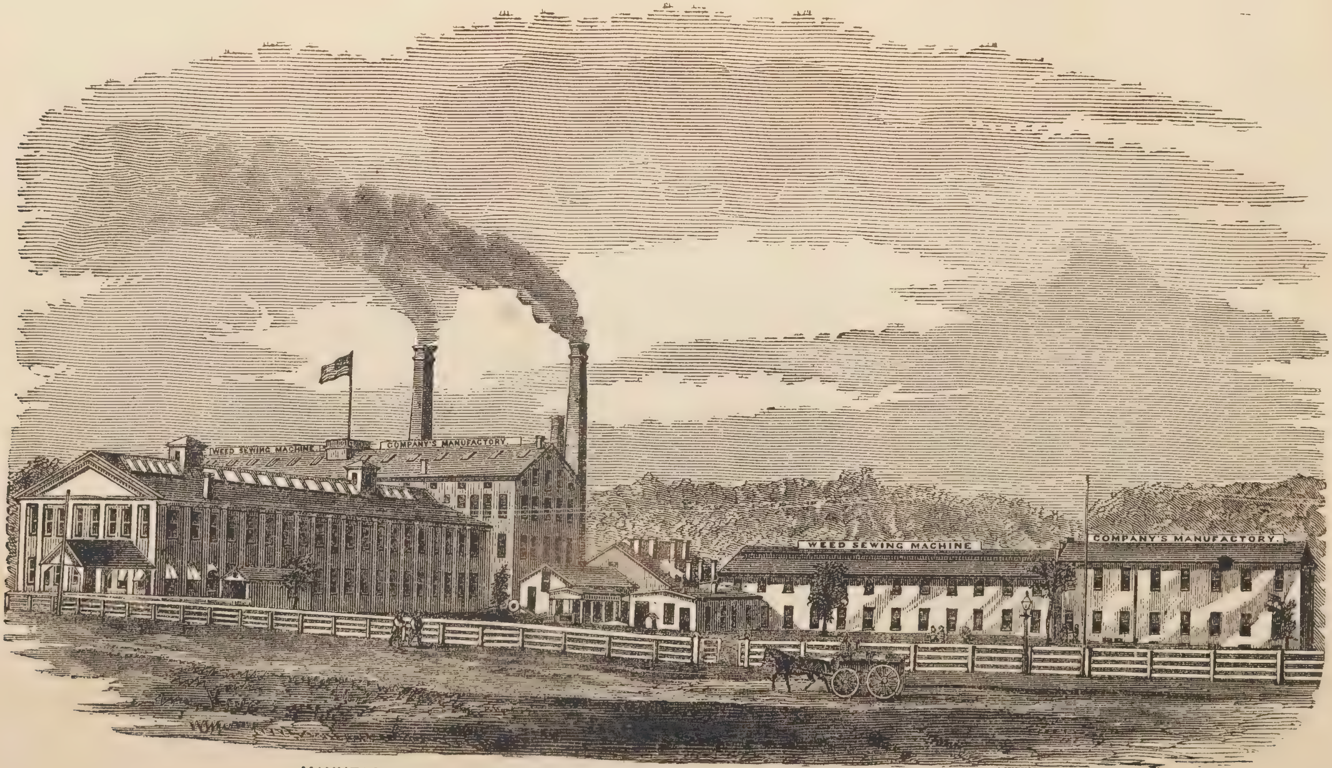
This machine was designed by Mr. George Fairfield, the superintendent of the Weed Company's works, to whose mechanical genius and talent for organization the productions of the company chiefly owe their well-earned reputation. The credit of its ingenious mechanism, which makes a new era in the history of sewing machines, is due entirely to him, and this the Weed Company have acknowledged in branding it with his initials.

The chief point aimed at in the construction of this new machine was to make it a really noiseless one; and early in his endeavors to attain this end, Mr. Fairfield found that he must abandon the mechanical devices heretofore used in sewing machines, such as cams, gears, and similar appliances, and replace them by something else. With this view, he introduced in their place a swinging or rock motion, by which to avoid the nervous grinding of the cams, and the harsh clatter of the cogs and gears in ordinary use.

The essential merit of this new combination is simplicity and perfection of mechanical motion, together with a perfect freedom from the friction and jarring incident to the ordinary mechanism of the sewing machines heretofore made.

By this means, also, not only is all noise avoided, but a rate of speed much higher than that heretofore attained becomes possible with these machines. This merit is one which will specially commend the G. F. to manufacturers, with whom time is most practically money.

A still further improvement in this machine is a novel device for feeding, by which all wearing points are avoided, and which is readily adjusted from the top of the bed. As it works also directly under the material to be sewn, it avoids all long levers and the



MANUFACTORY OF THE WEED SEWING MACHINE COMPANY, HARTFORD, CONN.

variations in the length of the stitches which are caused by their springing.

The uneven tension between the upper and lower threads, which all experts know is an objectionable feature in almost all the machines heretofore made, is also avoided in the Weed machines by the introduction of a delicate, adjustable pad arranged in the shuttle, and under which the thread passes. Its tension is thus secured without the necessity for the short curves and corners, by which it is chafed, and which have heretofore rendered it impossible to secure a perfect tension.

With the upper thread, also, in the sewing machines as constructed ordinarily, the tension is secured by passing the thread round corrugated wheels, or between disks, or under a spring or clamp.

All of these various methods are objectionable. The corrugated wheels may stick; or, when the thread passes between disks, the twist in the thread is destroyed; or, in this case, as also when it passes under a clamp, a knot, or any unevenness in the thread itself, makes a difficulty in the way of its even tension and regular supply.

In the G. F. machine, however, these objections are all overcome by the introduction of a vibrating or an anti-friction pad, which readily adjusts itself to any ordinary imperfection in the thread, and renders all unevenness of the tension impossible.

These improvements in the tension obviate the difficulties which have heretofore been, perhaps, the most evident in the way of perfecting the sewing machine, and their advantage will appear manifest to any one practically acquainted with the use of sewing machines.

In this machine, also, the shuttle is driven by a ball and socket joint, which is universally acknowledged to be the best mechanical device known for imparting motion; while all the joints and bearings in its mechanism are arranged to be so adjustable that any wear which may arise from long-continued, constant use, for manufacturing or other purposes, may be readily taken up without trouble to the operator, or expense for repairing. This is an improvement which appeals most forcibly to those who have had experience in the use of sewing machines for industrial purposes.

The increase of the consumption of sewing machines has raised their manufacture to one of the most important of the mechanical

industries of the country, and the economic value to the consumers of the organization of industry is, perhaps, nowhere shown more strikingly than in this branch of manufactures.

With the first introduction of the sewing machine, its cost appeared to be an almost effectual bar to its general acceptance. It would cost to-day some hundreds of dollars for a mechanic to make a single sewing machine, from a model before him ; and the first sewing machines made cost fully this amount.

The first introduction of sewing machines was less than thirty years ago, and yet, at that time, it has been stated that the original inventor could not have filled an order for a dozen machines at a less price than five hundred dollars each. There was not the machinery in existence to make the various parts, and they had, consequently, to be all made by the tedious and expensive process of hand labor. Now, however, in a well-furnished and properly-organized manufactory, like that of the Weed Company, every aid of machinery is made use of, and sewing machines, constructed with a perfection of accuracy which it would have been impossible to attain thirty years ago, are now made in large numbers daily, and sold at a price which places them within the reach of every family of thrifty habits.

The influence of the change in our methods of domestic labor, which the sewing machine has been chiefly instrumental in producing, can hardly be over-estimated. We have seen only its beginning. The greater intensity and activity of the social forces set in action by the new spirit of industry, and the extension of the means for enjoying the luxury of propriety in dress among all classes, will produce in our social organization a change similar to that produced in the political world by the extension of political rights and responsibilities.

We live in an age of universal ideas, and the material questions of the time are rising to claim their proper position as the truly moral questions, which must be answered in the interest of no one class, but of all.

PRINTING AND THE PRINTING PRESS.

THE GERM OF THE ART. — BLOCK-BOOKS. — DISCOVERY OF PRINTING. — EARLY HISTORY. — KOSTER. — METELIN. — JOHN GUTTEMBERG. — FAUST. — SCHŒFFER. — SPLENDID SPECIMENS OF TYPOGRAPHY. — SPREAD OF THE ART IN EUROPE. — THE FIRST PRESSES IN AMERICA. — THE CAMBRIDGE "UNIVERSITY PRESS." — WILLIAM PENN'S PRINTER. — FRANKLIN'S PRESS. — PRACTICAL PRINTING. — COMPOSITION. — PROOF-READING. — IMPOSITION. — DISTRIBUTION. — TYPE-SETTING AND DISTRIBUTING MACHINES. — JOB PRINTING. — PRINTING IN COLORS. — THE PRINTING PRESS. — EARL OF STANHOPE. — NICHOLSON. — KÖNIG. — THE LONDON TIMES. — GEORGE CLYMER. — APPLEGATH. — ISAAC ADAMS. — NAPIER. — THE MESSRS. HOE. — AMERICAN PRESSES.

THE discovery of the art of letter-press printing is the glory of the fifteenth century; but the germ of the art existed more than three thousand years before, when the Egyptians engraved raised characters and symbols upon tiles and cylinders, which were afterwards *impressed* upon soft clay tablets, which were then baked and hardened. These are supposed to be records, and the use of stamps, from which many impressions could be taken, shows that the purpose was multiplication, to disseminate information. With these have been found clay and porcelain figures, on which the characters were evidently impressed singly, side by side, by stamps. The ruined cities of Asia also exhibit similar specimens, and Mr. Layard declares that "the most common mode of keeping records in Assyria and Babylon was on prepared bricks, tiles, or cylinders of clay, baked after the inscription was *impressed.*" European public museums and private collections contain many of these curiosities of the first steps taken in the art of printing.

It is strange that the Greeks and Romans were slower in discovering even this initial step in the art. The earlier specimens of Roman pottery, many of them exhibiting exquisite taste in manufacture, show almost no attempts at the impression of de-

signs or characters ; and that, too, when their monuments and public buildings bore sculptured legends and inscriptions in the Roman letters which we use to-day. But the first attempt was an immense step in advance. They made stamps of different sizes, bearing on their faces names and legends in raised characters reversed. These were of bronze or brass, and unquestionably were used to make impressions by means of ink or colors upon papyrus, cloth, or parchment. One of them, preserved in the British Museum, has a face two inches by four-fifths of an inch, with letters and a border, which are here given in *fac-simile*. It is the *signet* (S N.) of C. I. (*Caius Julius*) CÆCILIVS HERMIAS, and with modern printer's ink it makes a clear and handsome impression upon paper, while the ring or handle on the back leaves no doubt whatever of its object as a stamp for printing.

CICAECILI
HERMIAE SN

That the Romans of that period should have just missed the discovery of block-printing by the page, which the Chinese claim to have known before the Christian era, is indeed surprising. In fact, there has been no material improvement in Chinese printing from its beginning, and for obvious reasons — their written language contains from eighty thousand to one hundred thousand characters, so that block-printing would be easier and more rapid than the use of movable type, since the number of characters required — at least sixty thousand — would make composition quite impracticable.

But from the Roman stamps and (claimed) Chinese block-printing, centuries elapsed before comparatively civilized nations knew even this much of the art. Of course wood-cutting was the beginning ; first for the manufacture of playing-cards, certainly as early as in the fourteenth century ; and then followed many rude engravings, generally of scriptural subjects, with legends or texts annexed. Prominent among these was the "Poor Man's Bible," consisting of forty leaves from as many different blocks. In this book, and in the *Canticles*, and the *Speculum*, certain pages were printed from movable type, and with this fact, admitted by bibliographers, comes at last the great discovery of letter-press printing.

But who was the discoverer? Harlem claims it for Koster (or

Custos), Strasbourg for Metelin, and Mentz for Guttemberg. It is not intended here to more than mention the discussion, which extended over three centuries, and space permits only the briefest statement of the prominent and really important facts in the earlier history of the art. It is probable that many of the small tracts, printed on movable type previous to 1440, were issued by Koster. The actual invention of letter-press printing is now, however, almost universally attributed to Guttemberg.

John Guttemberg, of Mentz, was the first to cut type from metal, and he afterwards cut matrices in which type was cast. He was a man of means, but these were exhausted in experiments. He then applied to John Faust (or Fust), a wealthy citizen of Mentz, to whom he revealed his plans, and who became his partner. Subsequently was associated with the two Peter Schœffer, a scribe, to whom many attribute the invention of the matrices for type-casting. In 1455, or thereabouts, — for the volume has no date, — this firm printed the famous "Mazarine Bible."

Faust and Schœffer separated from Guttemberg, and, in August, 1457, issued the celebrated Psalter, printed on large, cut type, and the first book which ever bore the date, place of issue, and names of printers. In 1462 they printed the famous Latin Bible, and in 1465 they printed *Cicero de Officiis*, in which occurs the first Greek type. Together Faust and Schœffer printed ten books, and after his death, Schœffer carried on the business for thirty-five years, during which he issued many books. The type used was what is called Gothic, with illuminated initial letters, generally done by hand, though Faust and Schœffer printed them in two colors. Parchment and paper were used indiscriminately. Of the character of the work and the mechanical skill, Dr. Dibdin, the bibliographer, says, "Everything is perfect of the kind — the paper, the ink, and the register."

Guttemberg died in 1467, poor, it is believed, and unhonored, it is known. It was reserved for a later century to rescue his name from the obscurity into which it fell. Not one of his books bears his imprint, and others derived the immediate emoluments, and, for a long time, the sole honor of his inventions.

Unless we except Metelin, of Strasbourg, who printed books as early as 1460, for a long time the Mentz printers had the monopoly of their art, and were sworn not to reveal it. But the capture of the city by Count Adolphus of Nassau, in 1462, not only interrupted the labors of Faust and Schœffer, but scattered their

workmen to other cities; so that within eighteen years the art had so spread that there were ninety-four printing-offices in full operation in different European cities. Nicholas Jenson, who learned his trade at Mentz, had the honor, at Venice, in 1471, of introducing the Roman type, which is used to-day. To the famed Aldine Press, established by Aldus Manutius at Venice in 1488, we owe the Italic letter. The earlier printers used only the period and colon; the comma was introduced many years later; and in the first printed books capitals were rarely used in beginning sentences.

William Caxton carried the new art to England in 1474, and printed "The Game of Chess," the first book in London. His press was in one of the chapels of Westminster Abbey. The scarcely less famous Wynkyn de Worde was Caxton's successor. Presses were speedily established at Oxford, St. Albans, and Cambridge. The introduction of printing at other important points is as follows: —

Paris, 1470; Florence, 1471; Antwerp, 1476; Geneva, 1478; Vienna, 1482; Stockholm, 1483; Copenhagen, 1493; Cracow, Munich, and Amsterdam, 1500; Edinburgh, 1507; Dublin, 1551; and Mexico, 1569.

Seventy years later, in 1639, the first printing press in the American colonies was set up at Cambridge, Massachusetts. It was procured by subscription (the Rev. Jesse Glover acting as agent) from Amsterdam, and was given to the college, with a fount of type of forty-nine pounds; so that it may be assumed to be the beginning of the present "University Press." The first issue from this press was the "Freeman's Oath;" next, "An Almanac for New England, calculated by William Pierce, Mariner;" and next a metrical version of the Psalms. On this press was printed, in 1663, the first edition of "Eliot's Indian Bible." It was wholly set by an Indian, was three years going through the press, and was the first Bible printed in America. Stephen Daye was the first printer at Cambridge, and he received a grant of three hundred acres of land on that account.

William Penn brought William Bradford, printer, to Pennsylvania, in 1686, and established a press in Philadelphia. In 1692 Mr. Bradford was invited to establish a printing-house in New York, with the inducement of forty pounds a year, and the "privilege of printing on his own account," which he accepted; and the first printed issue in that province is a proclamation, bearing

FRANKLIN'S PRINTING PRESS.

FAUST'S FIRST PROOF FROM MOVEABLE TYPE.

date of that year. At New London, Connecticut, a press was set up in 1709; at Annapolis, Maryland, 1726; at Williamsburg, Virginia, 1729; at Charleston, South Carolina, 1730; at Newport, Rhode Island, 1732. At Newport, by the by, in the old *Mercury* office, was used for many years a press brought from Boston, on which Benjamin Franklin worked as a "ball boy." This curiosity is now the property of the United States government, and is in the Patent Office at Washington. Other presses were established as follows: At Woodbridge, New Jersey, 1752; at Newbern, North Carolina, 1755; at Portsmouth, New Hampshire, 1756; Savannah, Georgia, 1762. Kentucky had a printing press in 1786; Tennessee in 1793. William Maxwell set up a press in Cincinnati, Ohio, in 1793. The first printing west of the Mississippi was at St. Louis, in 1808, by Jacob Hinkle. Louisiana had a press immediately after her acquisition by the United States; Michigan had a press in 1809, and Mississippi in 1810. Halifax boasts of a printing office in 1751, and Quebec in 1764.

To go back briefly to the early European printers: Before the year 1500 almost every known manuscript of antiquity was printed. These were in quartos or in folios, generally on parchment, with initial letters superbly colored and gilded by hand; and this practice was long continued, till very beautiful initial letters, cut on wood, were substituted. Many of these printed volumes, with all our boasted "advance in the art," have never been surpassed in mere mechanical execution, and certainly not as works of art. Some of these volumes exhibit now ink of a dense blackness, and colored inks of a brilliancy which no books of modern times can show. For in the days when the press was almost wholly devoted to the production of sumptuous Bibles for cathedrals, and superb copies of the classics for libraries, or for wealthy purchasers, printing was a luxury, and not, as now, a necessity. The march of centuries, and the universal diffusion of the art, have naturally compelled vast improvements in presses, paper, type, and office material; but the art itself, in taste, correctness, and practical skill, has not greatly improved. Printing is printing, and those who compare the mere letter-press of to-day with that exhibited in the volumes of Guttemberg and his contemporaries will declare that the art sprang forth, Minerva-like, full grown.

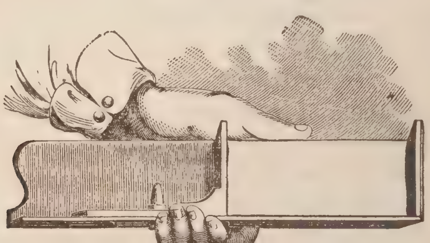
With this condensed historical sketch of the origin and progress of printing in the past, we proceed to consider the present process of book-making.

Composition.

When the manuscript or "copy" of a work to be printed is received in the "composing-room," it is apportioned in "takes" among the "compositors," who are to set it up in type. Each compositor has before him, on a stand, two "cases," which slope towards him in angles convenient to his hand, the upper case being more inclined than the lower one. The upper case is divided into ninety-eight equal spaces or "boxes," and the part on the left of the broader division is devoted to CAPITAL letters, figures, particular "sorts," etc., while the right contains the SMALL CAPITALS, accented letters, and references. The letters and figures are arranged, with one or two exceptions, in alphabetical and numerical order from left to right. The lower case is divided into fifty-four boxes of varying sizes, according to the average occurrence of the letters, containing the small letters, punctuation points, figures, and spaces of different sizes.

The "lower-case" letters are not arranged in alphabetical order; if they were, the work of the compositor would be doubled; but the larger boxes, which hold the most frequently-recurring letters, are in the centre of the case, nearest at hand. Separate cases, similarly arranged, contain the *italic* letters, and there are still other cases for accented (à) and diæresis (ë) vowels, superiors (^{a,b,c}), fractions, etc. The compositor never looks at the face of the letter, but, apparently without effort of the mind, puts his fingers in the particular box where the letter should be.

Placing his copy before him on the upper case, the compositor takes in his left hand a "composing-stick," which is a steel frame



COMPOSING-STICK.

with a slide, which can be adjusted and fixed to the "measure" or width of the page. In the stick is a thin brass or steel "rule," on which to slip the types to their places, and to prevent the lines

already set from falling over. Reading a few words of the copy, the compositor takes a capital letter from the upper case, and succeeding letters from the lower case, one by one, with a "space" at the end of each word, securing the increasing line in its place with his thumb till the line ends. If the words with the spaces do not fill, or if they crowd the line, the compositor gains by "spacing out;" i. e., by putting in more or thicker spaces, or, on the other hand, takes out the thick spaces, substituting thinner ones, taking care that his "matter" shall not look too close or too open, till the line tightly fills the stick. This is "justifying." He then takes out his rule, places it in front of the line just set, and repeats the operation till his stick is full. If the matter is to be "leaded,"—that is, if the lines are to be more apart,—the compositor, after setting each line, and before removing his rule, places before the line one or more thin pieces of metal, called "leads," which are of the exact width of the page, and not higher than the spaces. The stickful is then "emptied;" that is, by a dexterous operation the compositor lifts the lines, and places them upon a flat surface, usually of brass, with a rim to sustain the standing type, and called a "galley."

Compositors are usually paid by the "thousand," not a thousand letters, but for the space occupied by a thousand of the letter "m," and the payment is for "corrected" matter.

Proof-reading.

The matter on the galley is divided into pages, the head lines are added, "proofs" are taken by hand on a press for that purpose, and are sent to the proof-reader. He first looks over the proof, and satisfies himself as to all the technical points, whether the directions given have been followed, and marks whatever he finds wrong. An assistant — generally a boy — then reads the copy, while the proof-reader, with vigilant eye, sees that copy has been carefully followed, meanwhile rapidly noting on the margin of the proof all errors in spelling, turned letters, capitals, italics, or other blemishes and peculiarities, which, in a proof not "clean," will soon cover the margin with letters, words, and signs. The proof is then sent to the compositor, who corrects his own matter, takes a "revise" on the proof-press, sends it to the reader, who compares it with the first proof, to see that the corrections indicated have been made, and then carefully reads the revise for any errors which may have escaped him in the first proof. A third proof is

then taken, and sent to the author. If he materially changes the text from the original manuscript, the subsequent corrections are, very properly, at his expense.

Imposition.

When the corrections are complete, if the work is to be "letter-press," that is, printed directly from the type, the pages are taken to the "imposing-stone," a large marble slab, or sometimes a lathe-turned plate of iron. On this table the pages are laid down correctly, and a "chase" — a frame of iron divided by bars into compartments — is placed over them, and the spaces between the pages are filled in with "furniture," — pieces of wood or metal, — while inside the chase, and next to the pages, are placed side and foot sticks, and between these and the chase are put in wedge-shaped pieces of wood, called "quoins." These are sharply driven up with a mallet and a "shooting-stick," — a piece of hard wood, or iron, a foot in length, — and if the work is well done, the "form" is securely "locked up," and may be lifted without danger, and sent to the press-room.

Distribution.

When the sheets are printed, the pressman returns the forms to the composing-room, where they are carefully washed with lye, rinsed, laid on a board in the sink, and unlocked. The compositor then loosens the type with his hand, at the same time pouring on water to wash away the lye and ink, and the type are then left to drain. This is now "dead" matter for "distribution" to the cases, which have "run low." Wetting the face of the type to make it adhere, the compositor takes up a portion — nick upward, and face towards him — on his setting-rule in his left hand, while with his right he takes a word or more, gives a rapid glance at it, and drops each letter in its proper box. Remembering that the greatest accuracy is necessary, since errors in distribution will certainly cause errors in composition, to the grief of the compositor, who must gratuitously correct his matter, the rapidity with which the distribution is effected is indeed wonderful. It depends, of course, upon the size of the "fount," and of the book; but whether the type is sent to the press or to the stereotyper, in the printing of a single volume the type would be returned several times to be distributed and composed again.

Type-setting and Distributing Machines.

A *perfect* type-setting machine is yet to be discovered. Several inventors have attempted it, the most successful of whom was Timothy Alden, of Massachusetts, who obtained a patent for a machine; and since his death, his nephew, Mr. H. W. Alden, has organized a company for the manufacture of the machine. The machine is operated by means of keys, like those of a piano, and the type are made to form themselves into words and sentences at the will of the operator. The difficulty, however, with this, and with all the machines, is in "justification," which must be done by hand after the type is set, thus rendering the services of the machine comparatively valueless. It is claimed that the machine invented by Mr. F. G. Foster, of North Carolina, solves this difficulty. Distributing machines have also been invented, which take up "dead matter" and distribute it, sort by sort, in the different boxes, with marvellous rapidity and tolerable accuracy. While all these machines display wonderful ingenuity, their disadvantages, yet to be overcome, render them impracticable at present.

Job Printing.

Within a few years there has grown up a demand for a distinct class of printers, who are known as job printers. These are the useful citizens who fulfil nearly all the printing demands which business or pleasure may require, who print everything, from the business or ball-room card to the gigantic illuminated poster that covers the theatrical bill-board, and sometimes the whole "side of a barn." A few years ago, such jobs as were required in the way of cards, bill-heads, posters, etc., were done in the plainest, oftentimes in the poorest manner, in the newspaper or book-printing offices; now, great and small job establishments in all the cities vie with each other in turning out work which displays not only admirable mechanical skill, but frequently the highest artistic taste.

And hence the type-founders have furnished, and are constantly devising and providing for this especial class of printers, an infinite variety of large and small letters, borders, and beautiful designs of all sorts, which enable the compositor to turn out work so delicate and so elaborate as to vie with lithography and engraving. The job printer is not confined to regular founts of Roman and Italic, and limited to black ink; he may — indeed, he must —

use all the fanciful forms of type which the imagination of the type-founder has yet conceived, and he can indulge in all the colors of the clouds at sunset. In addition, then, to a complete knowledge of his business as a first-class compositor, he should be a man of thorough good taste; in short, an artist. He has not merely to please himself and his patron, but in many cases, as in posters, programmes, and the like, which meet the eye on every side, he must please the public. But the printer is often blamed or laughed at by the public for an inartistic or grossly tasteless piece of work which the patron compelled, while the taste of the printer rebelled.

The character of the work in a job office precludes the employment of "piece-hands," as in newspaper and book establishments, though many of the operations are the same. The proofs are generally submitted to the customer, and if approved are sent to the press. The job business throughout the country, especially in the large cities, is enormous, and in some of the larger establishments is very profitable.

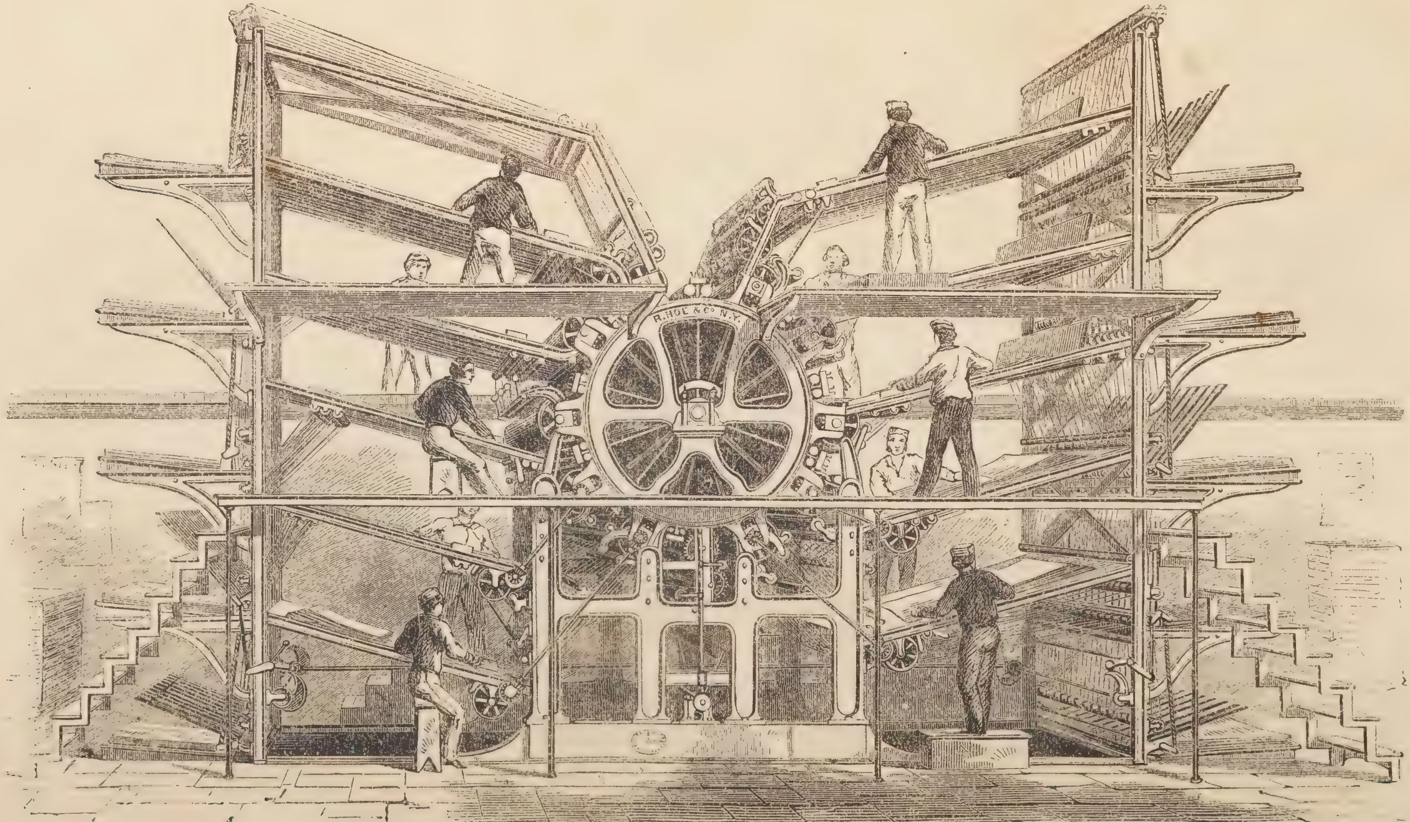
Printing in Colors.

The origin of printing in colors was an effort to reproduce by types the gorgeous illuminations wherewith the old scribes illustrated their manuscripts. The early printers were profuse in these richly-colored letters, and in rubricated lines; and nearly all the books of the contemporaries of Guttemberg, and of the printers of the immediately succeeding century, show page printing in two and three colors, which has never since been surpassed. We seldom see color printing nowadays, except in books which are intended especially as specimens of the beautiful in art rather than as "books which are books."

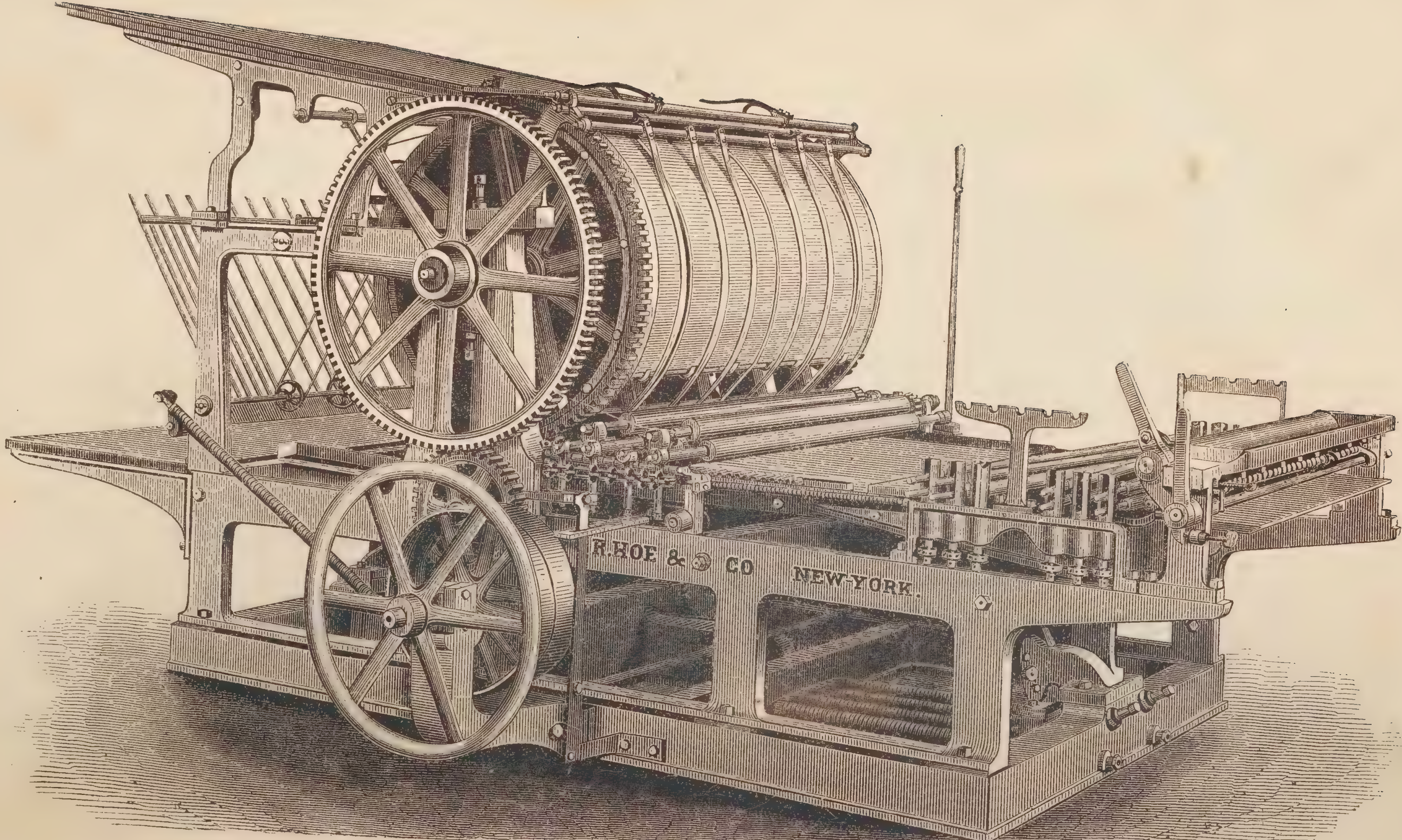
But the job printer still has the opportunity, and improves it. Manufacturing interests, too, have created an immense demand for bronze printing, in which a size is used instead of ink. The bronze powder is then applied to the sizing, and the loose particles are brushed off. This was formerly done by hand, but is now successfully performed by the rotary bronzing machine.

The Printing Press.

Before the days of Guttemberg, the few block-books, like the *Speculum*, the "Poor Man's Bible," and others, were printed by simply laying the leaf upon the inked block, and taking an im-



TEN CYLINDER TYPE-REVOLVING PRINTING MACHINE.



SINGLE LARGE CYLINDER PRINTING MACHINE.

pression by burnishing, or friction, as we take sometimes a hasty proof of a wood-cut now. The first printing press was simply the lower end of a large wooden screw upon the paper on the types, and the first "improvement" was simply putting a heavy piece of plank under the screw to equalize the pressure on the face of the form. This rude press, with immaterial modifications, was in use well into the eighteenth century. The Earl of Stanhope devised an iron press, combining the screw with the bent lever, and having a carriage for the form, which could be run in under the point of pressure, and readily withdrawn. This press also had a spring, which, when the impression was made, caused the iron plate ("platen"), which pressed upon the form, to fly up, and permit the withdrawal of the form.

In 1790, Mr. William Nicholson, of England, took out a patent for a cylinder machine, which had also an inking apparatus. This press was never brought into use, but it furnished the suggestion for after constructors.

Frederick König, of Saxony, was the first to construct a cylinder machine to run by steam. This press was built for the *London Times*, and the number for November 28, 1814, was worked by it at the rate of eleven hundred impressions per hour.

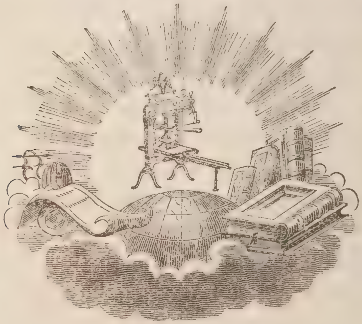
George Clymer, of Philadelphia, in 1815, constructed a combination lever press, called the "Columbian," which would print by hand two hundred and fifty impressions per hour.

In 1827, Messrs. Applegath & Cowper constructed for the *London Times* a press with four-impression cylinders, so arranged that two were in contact with the type as the table passed to the right, and two as it passed to the left, and which would print from four thousand to five thousand impressions per hour. Mr. Applegath was the first to abandon the plan of placing the type on a plane table, and built a press in which the type was placed on the surface of a cylinder. The *London Times* was the first newspaper to adopt the improvement. This is the beginning of all cylinder presses, of whatever manufacture and of whatever number of cylinders. In printing newspapers with these presses, each page is locked up on a detached segment of the large cylinder, called a "turtle."

Isaac Adams, of Boston, patented, in 1830 and 1836, a press, not cylinder, which is peculiarly adapted to book-work. The Napier press, in England, enjoys a similarly good repute for this class of work. The Napier press was introduced into the United States in 1830.

From this time the printing press, especially in the United States, has been so improved as very nearly to have reached perfection. This advance is largely due to the inventive genius of the Messrs. Hoe, of New York. Robert Hoe, who, with his partner, Sereno Newton, constructed the first two-cylinder press in this country, died in 1833. His son, Richard M. Hoe, who inherited the ability and energy of his father, continued the business, and opened a new era in the manufacture of printing machines. The "Hoe Double-cylinder Press" was followed by "Hoe's Lightning Press;" then other larger and better machines followed in quick succession, till now Hoe's eight-and ten-cylinder presses are used in nearly all the great newspaper offices of the country, and their approval and adoption by the *London Times* is an acknowlment that Americans are the champion printing-press manufacturers of the world.

The proprietor of the *Warrington* (England) *Guardian* patented, in 1871, a steam type-composing machine, which has been successfully used in several English printing offices. It is claimed that this machine, with one man and three boys to feed the type and space out the lines, will set up a newspaper column, as large as a column in the *London Times*, in one hour, which the inventor asserts is equal to the composition of eight men. The machine costs five hundred pounds.



WATCHES, AND MACHINE WATCH–MAKING.

THE WATCH: ORIGIN OF THE WORD. — THE BELL. — THE CLOCK: EARLY HISTORY. — THE CLEPSYDRA: ITS ETYMOLOGY: THE CHINESE USE IT: DESCRIPTION. — THE HOUR GLASS: PERSIAN CALIPH'S GIFT TO CHARLEMAGNE. — GALILEO AND THE PENDULUM. — TOWN CLOCKS. — MANUFACTURE IN THE UNITED STATES. — CONSTRUCTION OF THE WATCH, ETC.

THE word *watch* comes from the Saxon *wœccan*, signifying to wake, to excite, and is the name applied to the numerous species of time-markers which have sprung legitimately from that old *stirps*, or "stock," the "clock" — the earliest history of which is lost in the night of the past, but which has played so wondrous a part in the civilization of the world; and who knows but in barbarism too? for the meaning of the term originally was "bell," and is still retained in the French *cloche*. And since it is probable that the first sound man produced by artificial means was the resonance of bodies struck together by the hands somewhat as the tongue of a bell strikes its sides, it is quite likely that the "bell," and consequently the "clock" in embryo, were among the very first conceits and mechanical accomplishments of primitive man.

Yet in the very early ages there could have been but little need of any measurers of time save those which nature affords; as the day and night, the rising and the setting of the sun and the moon, and the numerous phases of the latter. Then, as human observation became more extended and accurate, the varying constellations marked the wider passages of time. So our aborigines

still count time by the moon's passages — "Ten moons haye gone;" and, indeed, in the field to-day for the laborer, and wherever in the backwoods men find it inconvenient, or are for other reasons unable, to afford the luxury of a supply of artificial time-keepers, the sun is made to tell the hour; "sun half an hour up," or "an hour before sundown," thus indicating the sun's place in the sky above the western horizon; and, indeed, since "one thought begets another," as we write we reflect that it is no great violence to etymology to find the root of "horizon" and "hour" primarily in the same Greek word, which signifies a bound, a limit; i. e., a measure. But it is useless, perhaps, however gratifying it may be to the imagination, to linger in speculation upon what were the earliest measures of time discovered in "revolving nature" by primitive man.

But one thing is certain — that motion, change, was a necessary "symptom" or index to the measure of time in the past as well as now. Out of positive silence and rest nothing could have been determined in this matter; and doubtless "Time," by whatever sweet name the Orientals may have blessed him, or by whatever uncouth or sublime sound the guttural Northmen may have told the sense of his presence and power, was among the earliest of the "gods" which man recognized. Little could the men of those rude early days have conjectured of the devotion which we, their far-off children's children, pay to Time, when in every house is erected an altar to his worship, and in every bosom is borne a jewelled monitor of his existence and "passage" along the course of "ever-moving creation."

But we must not tarry amidst the poetry which Time excites in his devotee's brain, for our title is properly "watch-*making*," and not its great promoter, Time.

Shadows are not "senseless shades," and have played their part in the measurement of Time's marches; and the dial was one of the primitive means of marking the divisions of a day, — so old at least as to be legendary, or pre-historic, — but it is believed that its origin was in the East. But the dial would mark time only on clear days. Obscuring clouds hid the sun, and some device was necessary to mark his place in the sky, above "the great wet veil," on stormy, dark days; so that very far back in the ages we have records of the "*clepsydra*," though by what nation invented no one knows. This term (from the Greek "*klepto*," to steal, and "*hudōr*," water) means "water-stealer," and signified in

the very poetry of the word itself, that as water "steals" away, drop by drop, through some crevice in a vessel that holds it, so time, for man, "steals" away from him. This instrument was a hollow cylinder, so graduated that the recession of the water within it readily marked the passage of the sun from horizon to horizon, at its various points of ascension to and declination from the meridian. The ancient Chinese, as well as the Egyptians, are said to have used this instrument; and the native Britons, if we are to accredit Cæsar, also made use of it. It appears to have been a valuable instrument, though imperfect, and subject, of course, to increasing inaccuracy, the longer used, by the almost imperceptible, yet certain wearing away which the trickling water caused, — the instrument at last delivering its given quantity of water more speedily than at first.

But the clepsydra naturally suggested the hour-glass, in which sand was substituted for water. Water would evaporate in all climes at times, and in some it would inevitably freeze. The hour-glass dates far back of the beginning of the Christian era, and supplanted the clepsydra almost everywhere; however, we are told that the latter is used in India even to-day. Both of these instruments were constructed in various shapes, according to the fanciful conceits of their fabricators, sometimes taking on the human form, sometimes that of fanciful beings, — in short, imitating everything in nature or imagination, the shape of which could be made to bend to the general principles of either. So much was finally added in the way of machinery to the clepsydra that it has been denominated by some writers as the "water-clock." So ingenious and complicated were some of these, that there seems to be but little, if any, room for doubt that the very earliest and most successful efforts of man's mechanical genius were expended upon time-measurers, and especially upon the clepsydra. The Persians appear to have carried the manufacture of this instrument to the highest perfection, and it is said that a Persian caliph sent to Charlemagne, emperor of the Franks (in the eighth century), a clepsydra which had a bell to denote the hours. It was so constructed that, when the twelfth hour was striking, twelve doors in its face opened, and from each door issued an automaton cavalier, who proudly stood, square and "stock-still," till the striking ceased, and then rode back into his "castle," shutting the door behind him!

The clock had its origin, according to some writers, thousands

of years ago, among the Chinese; but its invention has been claimed by many nations, and for several eras, it being claimed that the Germans, less than a thousand years ago, were its inventors. But for the last eight hundred years the history of the clock is quite clear.

The watch was originally, we find, a comparatively huge and "bungling" thing, and was moved by weights, — in short, it was only a "little clock," — a "pocket edition" thereof, as it were. Its case was at first made of iron, and on account of the weights it had to be borne about in a suspended position, as by a cord about the neck, hanging down on the breast. It was only a little over three centuries ago, about the year 1555, that the "spring" was devised, doing away with weights, and rendering the instrument more readily and safely portable. These springs were then only straight pieces of steel, not coiled, as now, and occupying more space. The watch of those days had but one index or hand, and required to be wound often, two or three times a day. The faces or dials were of metal, brass usually, and the cases were without crystals, but opened in front and at the back, not unlike the "hunting-watch" case of to-day. The case was from five to six inches in diameter — a "fashion" which modern indisposition to "bear about large weights" would hardly tolerate! As may be readily conjectured, the watch of those times was a very costly affair, worth more than many a New England farm now is, and requiring a long time in its construction. It is computed that the average value of the watches of those days was equivalent to fifteen hundred dollars of our currency.

Long years of experience finally enabled the Swiss and English manufacturers to produce watches of an appropriate size, of great beauty, and, in those of high cost, great exactness of time. It had always been supposed, owing to the want of experience, the great skill required, and the high cost of labor in America, that the business of watch-making could never be successfully introduced here; and there is no doubt that, even to this day, it would not have been attempted, had it not been for two ingenious, enterprising mechanics, who would never listen to the remonstrance of friends, or the ridicule of the unbelieving, but persevered until their efforts were crowned with success.

Those two persons who devoted their united talents and their thoughts to solve the problem of introducing machinery into watch making, together with a comprehensive system, which would enable

them to make a more perfect watch, and at the same time compete with the skilled and low-cost foreign labor, were Aaron L. Dennison and Edward Howard, both of Boston, Mass. Mr. Dennison was a thorough watch-repairer, one of the very best. Mr. Howard was a thorough-bred clock maker, one of the firm of Howard & Davis, both of whom had learned the trade of one of the celebrated Willards. In 1848 Mr. Dennison suggested to Mr. Howard the feasibility of making watches by machinery, conducted on a system of interchange of most of the parts, and they often had long discussions of the matter.

They knew that the foreign makers had no system to work on, because any two of the parts of watches of the same size, by the same maker, were far too unlike to be interchanged. That want of uniformity argued a want of machinery as its cause. After they had thoroughly canvassed the matter for two years, they determined to commence action. Mr. Dennison, closing out his business of jeweller and watch repairer, entered the clock factory of Howard & Davis, and, with Mr. Howard, they commenced a series of experiments to test their ideas, and as preliminary to extended operations.

Those experiments indicated that they were on the right course, and, in the summer of 1850, they, to increase the capital required, associated with them Mr. Samuel Curtis, of Boston, and a brick building one hundred feet long, twenty-five feet wide, and two stories high, was erected near the clock factory in Roxbury, Mass., now a part of Boston. That was supposed to be amply large to do an extensive business. The intention, at the commencement, was to make only eight-day watches. Only fifty of them were made, when it was found that no uniform and reliable time could be had from an eight-day watch, and that plan was abandoned. The accompanying cut exhibits the "upper plate" of the first watch ever made by machinery in America.

It seems simple enough, now that the thing has been done, to suggest the application of machinery to watch-making. But, as Columbus showed the scoffers with an egg that all the merit of his discovery of America consisted only in conceiving the idea and then executing it, so was it with this practical extension of the application of machinery to industry, by which a new era has been opened in our social advance, the final results of which no one can yet completely foresee. It is the first step which is difficult, since to make it presupposes the genius necessary to conceive it, and the courage to attempt it.

This watch is now possessed by Mr. Howard, as a memento of the first fruits of the enterprise. The usual thirty-hour watch was then commenced in the full plate form, and was as simple in its parts as possible, and the name engraved upon it was "Samuel Curtis." One thousand of them were made with that name upon them. At that time the copartnership name of the organization was the Warren Manufacturing Company. That name was used so as not to unnecessarily expose the kind of business being pursued.

After the first thousand watches were made, the copartners assumed the name of the "Boston Watch Company," and the business was continued at Roxbury till 1854, when a large factory in the form of a hollow square, one hundred feet on each side, and two stories high, was built at Waltham, Mass., and the entire business was then moved there. The business was continued there under Mr. Howard's charge till the spring of 1857, when the heavy outlay that had been needed for machinery, for making experiments, and instructing help, produced such financial embarrassments as to force the company to make an assignment of the property, which was sold for the benefit of the creditors. Mr. Howard's friends being overbid at the sale, he immediately returned to the original factory at Roxbury, and there reëstablished the business, with new and improved machinery, and commenced making watches of higher quality and high price. Mr. Howard has always been determined to improve and perfect both his watches and machinery. The factory has been enlarged from a two-story building one hundred feet long to a hollow square one hundred feet on each side and four stories high. Mr. Howard has, within the past year, produced a new style of movement, with a patented steel barrel, which protects the train from damage by the breaking of the mainspring, and is used as a stem winder, as well as a key winder. It is no doubt the best stem winder that is in use, and is already in great demand by the public.

In the factory at Roxbury both sexes are employed. The tools and machines are countless, and are fitted to perform the

most minute work — machines for shaving steel so minutely that the "product" can hardly be seen; registers for measuring the least conceivable part of an inch; drills so small that the holes they make cannot be seen without a microscope! etc., etc. In no department of mechanism is work required to be more minute and perfect than in watch-making. To the uninitiated, watch-making by machinery, at first sight, is nothing less than miraculous.

The inner "works" of a watch are made of brass and steel, in about equal quantities. Steel is used principally in those parts of the watch where the most strain comes on a delicate part; but brass is used wherever there is the most friction. Brass and steel rubbing against each other will last twice as long as two pieces of steel of like size when rubbed together.

The steel and brass are brought to the factories from rolling mills in sheets, and with enormous shears are cut up into narrow strips; these are then further thinned, if required, between steel rollers, so finely that it takes four thousand of them to measure an inch! These strips are then subjected to a punching process, cutting them into whatever shapes required. Thousands of wheels a day can be cut out by a single machine under the guidance of one man.

The factory is divided into apartments for the manufacture and composition of the several parts of the watch: and we may as well go next to the Plate Room, where the plates of the watch are made, or, in other words, the framework, to which all the mysterious "inner soul," or working parts, of the watch are attached. The plates are here bored or drilled, for the insertion therein of the screws, pivots, and pillars. All the parts made in this room being finished, they are properly stamped and placed appropriately in little boxes to be carried on to another room, where they undergo further manipulation. With the aid of machinery a man can make more than sixty times as many of these "attributes," or parts of a watch, as by hand, in the same time. The plates of the watch are next engraved with the manufacturer's name, etc., and numbered.

There are forty-four screws in a watch, which constitute more than a quarter of all its pieces. These are made by swift-running little machines, attended generally by active girls, who change the fine steel wire into minute screws, adjust and "slot" their heads in almost "no time." The screws then pass through a

polishing process, and then are "tempered" by heat, and "come out" at last of fine blue color, perfected and ready to take their places in the delicate time-measurers. These screws are no larger, some of them, than a small grain of sand — it taking nearly one hundred and fifty thousand of them to weigh a pound. Think of the infinite smallness of the "thread" cut upon these! so small, indeed, as to be invisible to the unaided eye. Screws for some kinds of compensation-balances are made of gold.

The compensation-balance we will next notice. A piece of steel as large as a cent, enclosed in a brass rim, is ground down and polished till it becomes only the slenderest wheel. Through the double rim twenty-two holes are drilled for screws. A boy can drill over one hundred wheels a day. The screws are put in, and the compensation-balance is finished.

In another department takes place the grinding of wheels, pinions, etc. Cutting teeth in the wheels is also a neat and rapid process. A number of wheels are piled up together around an upright shaft, which passes through a hole in the centre of each wheel, and is made fast. The person in charge of the cutting machine lifts a little lever, and away whirls the cutter like lightning, carving its way instantly through the whole length of the wheel-pile, grooving each properly and accurately. The whole process requires but a moment, and the wheels are fitly "teethed." There are in these factories the "escapement" and jewelling rooms, the mysteries of which are very engaging. Diamonds, sapphires, rubies, here dazzle the eye — valuable here only for their hardness, however. These are brought from all parts of the world — mostly from India, Persia, and Brazil. Watches of the first quality are jewelled with diamonds, sapphires, and rubies. The stones are cut into small slabs by circular saws, and then further cut up into the right sizes, and turned in lathes with diamond tools. The stones are, when finished, so small that it takes eighty thousand of them to weigh a pound.

Every part of a watch must be perfect, but not all parts closely fitting, for there must be a little "play" for the working parts, so that even every jewel-hole must be a particle larger than the pivot which is to move in it. These holes are measured accurately by gauges, which perform their functions with more than human accuracy.

The dial is made of a thin plate of copper covered with a fine white enamel in the state of a paste, which is thinly spread on

with a knife. After this paste becomes dry, the dial is placed upon a red-heated iron plate in the mouth of an intensely hot furnace, and is closely watched. The enamel prevents the copper from melting almost instantly under so great a heat. The dial remains in the process of baking for a minute, and when removed is soft and plastic. The baking "sets" the enamel, but leaves it in a rough state. It has then to be polished smooth with emery, and is again baked, and is ready for the ornamenters or painters. Points for the hours are marked out upon it, and it is then lettered, the minute marks added, etc.

The parts all being finished, the process of "putting together" follows next. The watch is at first but loosely adjusted in its parts, and is hung up to run a few hours, mainly to adjust the length of the hair-spring — a delicate thing to do. It is then taken down, and all the brass portions sent to the gilding department; and each part is there polished ready for the process of electro-gilding. Gold is rolled out into thin sheets, and dissolved by acids. The solution, as it goes into the battery, is as colorless as pure water. It is, however, a deadly poison, and must be "handled" carefully. Generally the parts submitted to the electric currents are left in the solution about five minutes, and come out beautifully covered with gold. All are then sent to the finishing department, where skilled hands re-adjust the parts of each watch, which is next taken to the inspector's office, who scrutinizes all, searching for the least flaw. The watch is then again tried in the adjuster's room, in order to "time" it. At first it is run for six or eight hours in a little chamber heated to one hundred and ten degrees, and next for a like period of time in a refrigerator, the temperature of which is nearly at zero. It is not perfect unless it will keep time equally well in both places. If there is any variation, this must be cured before the watch is allowed to "pass muster." Now the watch is ready for the case, — its one hundred and fifty-six different parts and pieces composing the perfect whole, — and put in the case, is perfect and guarded — finished, the stamp of its reliability appearing on its face in the words, printed in the most diminutive letters, "E. Howard & Co., Boston."

PURIFYING AND HEATING WATER FOR STEAM BOILERS.

THE NECESSITY OF PURE WATER FOR STEAM BOILERS. — SUBSTANCES HELD IN SOLUTION BY WATER. — THE TEA-KETTLE AND THE STEAM-BOILER. — METHODS OF FILTERING. — STILWELL'S LIME CATCHER. — THE WAY IT WORKS. — ITS ECONOMIC ADVANTAGES. — THE GREATER SAFETY GAINED BY ITS USE.

The general use of steam as a motive power in modern industry has made every suggestion by which the safety or the economy in its production is increased, a matter of great importance. In generating steam, it is evidently best to have the purest water with which to fill the boiler, since in its evaporation, as the water passes off into vapor, any extraneous substance diffused through it must be deposited upon the boiler itself, and beside its tendency thus to diminish the effective heat of the fire, it may be a substance having a corrosive and weakening effect upon the iron of which the boiler is composed.

Very early in the history of the steam engine attempts were made to remove the impurities of the water, so as to preserve the boilers from becoming incrusted with sediment. Though by the use of filters, of various kinds, the coarser impurities can be easily separated from water, yet the soluble salts of lime, which give to water the property known as hardness, being in a state of solution, will pass readily through simple filters. Water, which is otherwise pure, may thus contain about two grains of carbonate of lime to the gallon, or one thirty-five thousandth of its bulk; and as water absorbs carbonic acid gas, its capacity for dissolving carbonate of lime increases, until its capacity may be ten times greater than pure water. In proportion as water dissolves carbonate of lime its hardness increases.

For this reason the water from springs, especially in regions abounding in calcareous rocks, differs from rain water, which has

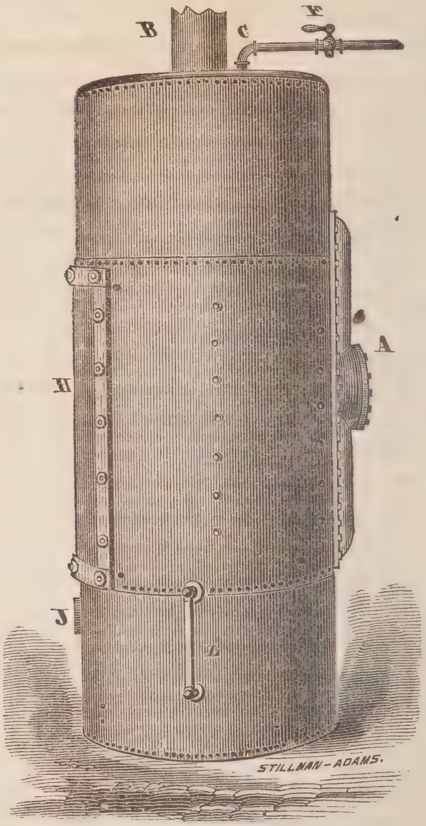
not percolated through the ground. When hard water is boiled, its excess of carbonic acid gas is freed, and its capacity for holding carbonate of lime in solution being thus lessened, the excess of lime is deposited as a sediment or crust, which collects on the bottoms of the vessels in which the boiling is performed. Every cook has had experience of this in her own tea-kettle.

By continuing the boiling all the lime, except about two grains to the gallon, may be thus separated. Other salts, the solubility of which does not depend upon the presence in the water of carbonic acid gas, such as sulphate of lime, chlorides of soda, magnesia, and so on, which give the hardness and saltness to sea-water, can be separated only by distillation. It is the same with many organic substances, and fine clayey or aluminous particles. The waters which flow over cliffs of clay become saturated with the impalpable material, and refuse to part with it by any wholly mechanical action. Water of this kind may be cleansed by adding alum to it, in the proportion of a few grains to the gallon, which causes the water to precipitate the alumina. Such a process, however, is objectionable, since it adds to the deposit, and a portion of the sulphate of lime which is formed still remains in solution, rendering the water hard.

The best practical combination of a heater and filter which has yet been invented, is Stilwell's patent heater and lime catcher, the general appearance of which is represented in the accompanying cut, No. 1. Not only does this invention purify the water from the impurities which would incrust the boiler, but it furnishes it to the boiler hot, thus saving the fuel necessary to generate steam, and to accomplish this, uses the exhausted steam from the engine itself, thus proving a double economy. These heaters are manufactured by the Stilwell & Bierce Manufacturing Co. of Dayton, Ohio.

The necessity for some device by which the incrustation of boilers should be prevented, having engaged the attention of Mr. Stilwell, after some time spent in experiments, he finally produced this present arrangement, which, the practical test of use for years has proved, is most admirably fitted for its purpose. Its interior arrangement is shown in cut, No 2.

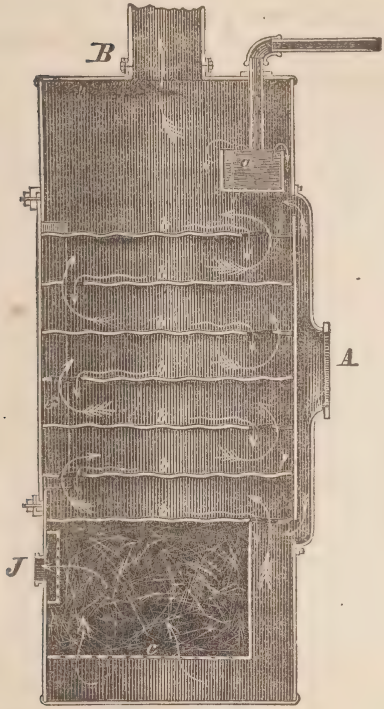
By using all the escape steam from the engine, and bringing it in contact with thin sheets of falling water, this heater is capable of purifying and heating a very large quantity of water. The steam, it will be observed, meets the water as it enters the heater, dashes it into spray, and the work of depositing begins immedi-



Stilwell's Patent Heater and Lime Catcher, No. I.

ately; the top shelf being always found to be most heavily covered. The shelves are easily removable when necessary; and experience has shown that this form is better than pans, since the deposit of salts takes place more rapidly and thoroughly when the water is passed in a thin sheet over a highly heated metallic surface than when it stands in a pan.

The system of upward filtering, followed in this arrangement, is so well known to be the best, that it needs only to be mentioned. This heater was first introduced to use in 1864, and the favor it has met with proves that it is indispensable in the most economic use of steam. Especially is this so where the hard water of a limestone country, or the muddy water of our western rivers, is used. To woolen or paper manufacturers, and others to



Stilwell's Patent Heater and Lime Catcher, No. 2

A. Steam enters the Heater, and is divided into two currents.
B. Steam escapes from the Heater.
C. Cold water enters.
F. Cock with which to regulate supply of cold water.
H. Door of Heater.
J. Hot water leaves Heater.
L. Glass water-gauge.
a. Overflow cup suspended on the end of cold water pipe.
bbbb. Removable shelves or depositing surfaces.
c. Filtering chamber to be filled with any suitable filtering material.

The feathered arrows indicate the course of the steam, and the plain arrows the course of the water.

The letters of reference, in both cuts, refer to the same parts.

whom a supply of pure water is necessary for their operations, this heater is equally valuable, as it furnishes an abundant supply of pure water, and is so simple in its construction.

For preventing the formation of deposit or scale upon the inside of steam boilers, it is one of the most economic devices. By careful experiment, it has been shown that a deposit of scale one-sixteenth of an inch thick causes a loss, by its being so im-

pervious to heat, of fifteen per cent. of the fuel, while the danger to the boiler from cracking of the scale, thus letting the water down to the heated plates of iron, is daily becoming better known to practical engineers. Both safety and economy unite in teaching that to keep the boiler plates clean is the first requisite of a steam engine ; and experience has shown that in attaining this desirable end the Stilwell heater is indispensable.

STEAM NAVIGATION.

THE APPLICATION OF STEAM TO THE CIRCULATION. — ADAM SMITH'S WEALTH OF NATIONS. — BUCKLE'S OPINION OF IT. — THE FIRST ATTEMPTS AT STEAM NAVIGATION. — JONATHAN HULLS. — FRENCH ATTEMPTS. — ATTEMPTS IN THE UNITED STATES. — OLIVER EVANS. — THOMAS PAINE'S SUGGESTIONS. — JAMES RUMSEY. — JOHN FITCH. — THE DISPUTED CLAIM OF PRIORITY. — FITCH'S FIRST BOAT. — HIS SECOND BOAT. — ROBERT FULTON. — HIS PARTNERSHIP WITH LIVINGSTON. — THE CONTEST WITH THE MONOPOLY.—LEGISLATION IN ITS FAVOR. — THE RESULT OF THE CONTEST. — ITS LESSON FOR THE PRESENT. — THE ATTEMPTS IN THE WEST. — THE FIRST BOAT TO ASCEND THE MISSISSIPPI. — OCEAN STEAM NAVIGATION. — THE IMPROVEMENTS IN OCEAN STEAMERS. — A COMPARISON OF THE OLD METHODS AND THE PRESENT ONES.

The application of steam to land and water travel and transportation is a step in the progress of mankind which separates the civilization of the modern from the ancient world more distinctly and definitely than perhaps any other single difference in their methods of industry or government. It has secured the circulation of the products of industry, and of man himself, and rendered possible the intenser action of the political, the social, the industrial, and the other forces which go together to make the life of nations. Less than a century ago, Adam Smith, in 1776, published his work entitled *The Wealth of Nations*, in which the foundation was laid of the science of political economy, and of social science as its subsequent outgrowth, and in which he speaks of the difficulty of transporting men from one place to another, even though the change should be one from want to plenty, from tyranny to freedom; and notices how loth the great masses of Europe are to attempt any improvement in their condition by changing their place of abode.

Of this work, Buckle, the author of the *History of Civilization in Europe*, says, most truly, "Adam Smith contributed more, by

the publication of this single work, towards the happiness of man than has been effected by the united abilities of all the statesmen and legislators of whom history has preserved an authentic record." This statement is true, though the comparison is one that can hardly be made, and is liable to a misinterpretation. It is unfair as a comparison of the respective worth of the statesmen and legislators before his time and of the author of *The Wealth of Nations*. They, with himself, their actions and their knowledge, were the results of the times in which they lived, and of the conditions with which they were surrounded. A comparison of their relative value to the human race, if it is made the basis of a moral judgment, is as unfair as would be the comparison of the actions and opinions of a child with those of the same individual after his maturity. As with the growth of a child, his errors and his mistakes are the necessary material of his experience, from which his maturer judgment can alone generalize the truth, and by their combination arrive at the rules and laws which should govern his actions and give him a method for forming, examining, and testing his opinions, — so with the slower growth of a nation's, or mankind's progress in civilization; the errors and mistakes of the early times are the necessary experience from which alone, by comparison, the generalizations of laws which should govern their political, their social, their industrial, and other relations, can be arrived at.

In this view, therefore, the legislators and statesmen who preceded Adam Smith were necessary precursors of the period in which he lived, and, together, each of them has done his part in aiding to produce the present condition of the world, when social progress is recognized as a growth regulated by law.

When Watt, taking up the steam engine, in the condition to which it had arrived in his time, perfected it, in a measure, and made it practically applicable to industry, the idea readily occurred of using it also for purposes of locomotion, and especially of navigation. In England and in France, which were at that time engaged in a rivalry in commerce, attempts to realize the introducing of steam as a motive power for propelling ships were frequent, but before 1730 had led to no practical results. In 1736 Jonathan Hulls published a description of a vessel which was to be propelled by a stern wheel, the motive power of which was to be an atmospheric engine; but there is no record of his having put his plan in operation. In France, during the period intervening be-

tween 1774 and 1796, the Count de Auxizon, the brothers Perier, the Marquis de Jouffroy, and M. Des Blancs had each attempted to construct a boat which should be propelled by steam; but all their experiments had proved failures.

In the United States, in Philadelphia, which at that time still retained much of the political importance she had held during the revolution from being the seat of Congress, and in which great attention was paid to commerce and ship-building, early attempts were made to propel vessels by steam power. As early as 1773 the attention of Oliver Evans had been turned to steam propulsion, both on land and water. Evans was the practical introducer of the high-pressure engine, and of various improvements in mill machinery, and his subsequent successful attempts to build a locomotive carriage, which ran in the streets of Philadelphia, and, with the same apparatus, a boat which was propelled on the Schuylkill with paddle-wheels, have, with some authorities, been supposed to justify his claim to the first contrivance of a practical steamboat. Whether this is so or not, yet it is certain that he predicted the ultimate triumphs of steam, and of his own method of propelling a boat. At the same time there were others in the United States whose attention was turned to the same subject.

Fitch mentions that steam navigation was the subject of a conversation between Mr. Henry, of Lancaster, Pennsylvania, and Mr. Andrew Ellicott in the year 1776. The former had even made drawings of a steamboat, which he intended to lay before the Philadelphia Society, but was probably diverted by the impending struggle.

In 1778 Thomas Paine, the author of *Common Sense*, whose writings have done so much for the success of American independence, and for the enfranchisement of the world's thought, recommended Congress to adopt measures for encouraging the building of steamboats on the plan of Jonathan Hulls, patented in England in 1736, and intended "to go against wind and tide."

In 1784 James Rumsey, of Maryland, showed to General Washington on the Potomac, the model of a boat for navigating rivers, against the current, by the force of the stream acting "on setting poles." This invention had been previously attempted without success, in 1750, by a resident of Reading, Pa.; yet Rumsey patented it in several states, and in March, 1785, obtained from the Assembly of Pennsylvania an exclusive right for ten years "to

navigate and build boats calculated to work with greater ease and rapidity against rapid rivers."

In 1785 John Fitch had completed the model of a steamboat, and the next year navigated the Schuylkill in a small shallop propelled by a wheel at the stern, driven by steam.

In 1786 Jefferson, writing from London on the 22d of April, appears to have been informed of this fact, for in a letter to Mr. Charles Thompson, of Philadelphia, he says, "I hear you are applying the same agent (steam) in America to navigate boats."

In the first volume of the *Columbian Magazine* for December, 1786, Fitch published an article descriptive of a new steamboat he was building, and in the following May he made an experimental trip with this first practical American steamboat upon the Delaware. Her speed was estimated by Messrs. Ritterhouse, Ewing, Ellicott, and others, who witnessed her performance, from their measurements to be eight miles an hour at dead water, and she afterwards went eighty miles a day.

On March 28, 1787, the legislature of Pennsylvania accorded to Fitch "the sole right and advantage of making and employing the steamboat by him lately invented for a limited time" — that is, for fourteen years; and subsequently the legislatures of Delaware, New York, and Virginia granted him the same privileges.

In December, 1787, James Rumsey, who has been mentioned as having exhibited to Washington and received from him a written testimony of the fact, a boat which moved against the stream, having turned his attention to steam as a motive power, propelled a boat by an engine and mechanism of his own invention upon the Potomac. This boat was propelled by the force of a stream of water driven out at the stern by a pump. His successful experiment was witnessed by a number of people who had gathered upon the banks. The inventor, however, became subsequently engaged in a controversy with Fitch concerning the priority of their respective inventions.

The next year (1788) a society, of which Franklin was a member, was formed in Philadelphia under the title of the Rumsey Society, for the purpose of aiding Rumsey in his inventions, who in the same year, having gone to England, obtained patents there and in France and Holland for some of them. With a boat constructed from his plans he made a successful trip upon the Thames in December, 1792, and was preparing for another when he died.

In 1839 Congress voted to his son — James Rumsey — a gold medal, "commemorative of his father's services and high agency in giving to the world the benefit of the steamboat."

In the dispute between Fitch and Rumsey, the claim of the first to priority of invention was sustained by the legislatures of Pennsylvania, Delaware, and New Jersey, while Rumsey's patents were allowed by those of New York, Maryland, and Virginia. Both inventors, on the establishment of the national Patent Office, took out patents for their marine inventions. The facts of the dispute between Fitch and Rumsey appear to be these: The credit of the invention belongs to each of them, since they both arrived at it independently, and without the knowledge of each other's labors; but while the conception of propelling boats by the energy of steam appears to have occurred to them both in the same year, Fitch was fortunate enough to have made the first practical experiment. But, unfortunately also, Fitch being a man whose peculiar idiosyncrasies of character were intensified by his independence of spirit, his inventive pride, his clear foresight of what the eventual value of his invention would be, and the misfortunes of his early youth, the troubles of his domestic life, and the want of appreciation he met with in his maturer years, it was difficult, if not impossible, for him to obtain the coöperation he needed. Yet there is no doubt that it was only defects in the size of the wheels, the imperfections and the excessive weight of the engine, and other quite secondary details of construction which were remedied by those who came after him, together with his want of capital, which alone prevented Fitch from making navigation by steam a success years before it became actually such in other hands.

Unsuccessful and unhappy, broken in fortune, and suffering from poverty and want even of sympathetic appreciation, he rashly ended a life which had become too great a burden to be borne. Yet still his countrymen should not willingly let his memory decay; but, with the growth of the enterprise he foresaw, an increasing appreciation of the value of his life should bring to his memory the recognition which was denied him while alive.

In 1788 Fitch built a second boat for the machinery he had used in his first, which was an engine with a twelve-inch cylinder, and made with it several passages between Philadelphia and Burlington, at the rate of about four miles an hour. This boat was driven by paddles, six on a side. Another boat for an engine with an

eighteen-inch cylinder was ready for trial in August, 1789. Changes in the machinery, which were found to be necessary, occupied the time until the spring of 1790, when the boat was run regularly to carry passengers between Philadelphia and Burlington, making an average speed of seven and a half miles an hour, and going over two thousand miles that season. This boat was driven by paddles at the stern.

This was the first American steamboat which regularly carried passengers.

In Scotland, in 1788, Patrick Miller and William Symington built a small double skiff, which was propelled in Dalswinton Lock by a four-inch cylinder engine, driving a paddle-wheel working between the boats, and reached a speed of about five miles an hour.

In 1789, with a larger engine, they propelled a boat upon the Forth and Clyde Canal, at the rate of from six to seven miles an hour; but their machinery being found insufficient, they abandoned further attempts.

In 1796, Fitch, having returned to this country from a trip to France, in which he had been again disappointed in obtaining the aid he needed for introducing his invention there, built a small boat, which was run on a pond in New York city, called the Collect Pond. This boat was propelled by a screw at the stern, while its boiler was a twelve gallon pot impressed into this unusual service, its top being covered with a plank which was secured in its place by an iron bar fastened down with clamps. This was the last attempt made by Fitch to realize his project. His death occurred two years afterwards.

During this time Robert Fulton, whose name is more generally known as connected with the introduction of the steam engine into practical use in navigation, was in England, where he had gone for the purpose of continuing the study of the art of painting under Benjamin West. While there he became acquainted with the Duke of Bridgewater, who was then carrying out his system of canal navigation in Great Britain, and, following his advice, determined to devote himself to engineering. A subsequent acquaintance with the Earl of Stanhope, who was an inventor, and then engaged in attempting to realize a method of steam navigation in which the paddles were to be shaped and to work like a duck's foot, turned his attention in this direction, and in a letter to this nobleman, dated 1793, Fulton expresses some of his

objections to this proposed method, and made some suggestions, which he afterwards followed himself in his attempt upon the Hudson. At Birmingham he became acquainted with Watt, and made himself perfectly familiar with the steam engine, which had just been improved by this inventor. On a visit to Paris he became intimate with Chancellor Livingston, of New York, who was then United States minister to France. Livingston had been connected in New York with Nicholas Rosevelt and John Stevens in experimenting concerning steam navigation, and, being wealthy, offered Fulton, when he heard his views, all the capital necessary for his experiments, and if they were successful to contract for the introduction of this new method of propelling boats in the United States.

Through Livingston's influence, also, an act was passed in the legislature of New York, in 1798, repealing the act of 1787 in favor of John Fitch, and granting to himself the exclusive privilege of navigating the waters of the state by steam, on condition that he should give proof, within a year, that he had constructed a boat of twenty tons which was able to navigate the Hudson River at an average speed of four miles an hour, and that he should at no time fail, for the period of one year, to have a boat of this description plying between Albany and New York city. From time to time the continuance of this act was extended, and finally its provisions were made to include Fulton.

In the mean time experiments were continued in France, and during the summer of 1802, at Plombières. The next year Fulton commenced constructing a working model, and at the same time a vessel sixty feet long and eight wide. It did not, however, move when finished with the speed he had expected. The same year he also sent an order to Watt and Bolton for a steam engine suitable for a boat of larger size, which, when completed, was forwarded to New York, arriving there in 1806.

Having informed himself concerning all the attempts made in Europe to realize steam navigation, so that he should be able to avoid the causes of their failure, he returned to America, and doing the same thing here, he set about constructing a boat for his machine. This boat was finished in 1807, and named the Clermont, the name of Livingston's estate on the Hudson. The speed she attained averaged five miles an hour, and during the ensuing winter she was lengthened so as to measure one hundred and forty feet on her keel and sixteen and one-half feet beam.

The legislature also granted to Livingston and Fulton an exten-

sion of their exclusive privilege for additional terms of five years for every new boat they should build and run, provided the total number of years so granted should not exceed thirty. The second boat built was finished in 1807, and called the Car of Neptune. Next year the legislature passed another act confirming the prior grants, and giving the grantees further remedies against any infringement of them, by subjecting any vessel propelled by steam, which should enter the waters of the state, to forfeiture, unless it had their license.

In 1809 Fulton took out his first patent from the United States for his invention, and in 1811 others for improvements in his machinery. These patents covered the adaptation of a paddle-wheel to the axle of the crank of Watts's steam engine.

It was naturally to be expected that in a country governed professedly upon democratic principles such a monopoly would be resisted, and very soon the power of the legislature to grant such an exclusive privilege was denied. The question was soon brought to a legal issue in the courts by the establishment of a company at Albany for the purpose of constructing another line of boats to ply between that city and New York. Livingston and Fulton, as grantees of the privilege, filed a bill in equity, asking for an injunction against the new company. Their request was refused by Chancellor Lansing, on the ground that the act of the legislature was repugnant to the Constitution of the United States, and against common right. This decision was, however, reversed by the Court of Errors; but the case was carried no further, being quashed by a compromise, in which the right to navigate the waters of Lake Champlain was granted to the Albany company. Thus in the very beginning of the course of modern methods of transportation the monopolists showed their readiness to avoid competition, by combining among themselves. Nor was the legislature more averse in those times than in the present to lend its aid in furthering the interests of the monopolists as against the people. Having in the first place granted a right which was not theirs to grant, they passed another act peremptorily ordering the granting of an injunction to the grantees of their privilege, and also ordering the seizure of any boat which should infringe upon the terms of their grant before the commencement of any suit against it.

By this arbitrary and unconstitutional legislation the steam navigation of the waters of New York State remained in the exclusive possession of Fulton and his partner until the death of Fulton

in 1815. But the contest was simply transferred to New Jersey, whose coast abutted on the mouth of the Hudson River. Here, however, the promptness with which monopolists will combine was again illustrated. Colonel Aaron Ogden, who had commenced to contest the claims of Fulton and Livingston under the grants of the legislature, was converted, by concessions on their part, into becoming the warmest advocate of the monopoly, and maintained it until eventually he was defeated in the famous case of Gibbons against Ogden, in the Supreme Court of the United States, where the question had been carried by appeal.

The same course of procedure was also forced upon the West to secure the free navigation of her streams. In 1814, Fulton, claiming the monopoly of steam navigation upon the western rivers, built at Pittsburg, for a company at New York, Philadelphia, and New Orleans, a steamboat called the Vesuvius, of three hundred and forty tons. She was the third boat built at the West, and was intended for the New Orleans and Louisville trade. In the spring of this year she sailed from Pittsburg, and in July started with a cargo from New Orleans, making in ten days one-half the distance between there and Louisville, when she grounded, and remained until December, when, being floated off by a rise in the river, she returned to New Orleans.

The first steamboat to navigate the western rivers was also built by Fulton at Pittsburg. She was called the New Orleans, and had a capacity of between three and four hundred tons. She was provided with a stern wheel and sails, since at that time Fulton supposed these would be needed in addition to her engine. In October, 1812, she made the trip from Pittsburg to Louisville in seventy hours. Being detained there several weeks by the condition of the falls, she made several trips to Cincinnati, and in December proceeded to New Orleans. Her length was one hundred and thirty feet, and her breadth thirty. Her cost was about forty thousand dollars, one-half of which was received from the net profits of her first year's business. From New Orleans she proceeded to Natchez, and engaged in the trade between these two cities, for which she was built, until 1814, when she was wrecked upon a snag at Baton Rouge.

The second steamboat of the West was a small boat, rated at twenty-five tons, called the Comet. She was built at Pittsburg by D. French, and provided with machinery which he had patented in 1809. In the summer of 1813 she descended to Louisville, and

in the spring of 1814 to New Orleans. After two voyages to Natchez, she was sold, and her machinery taken for a cotton mill.

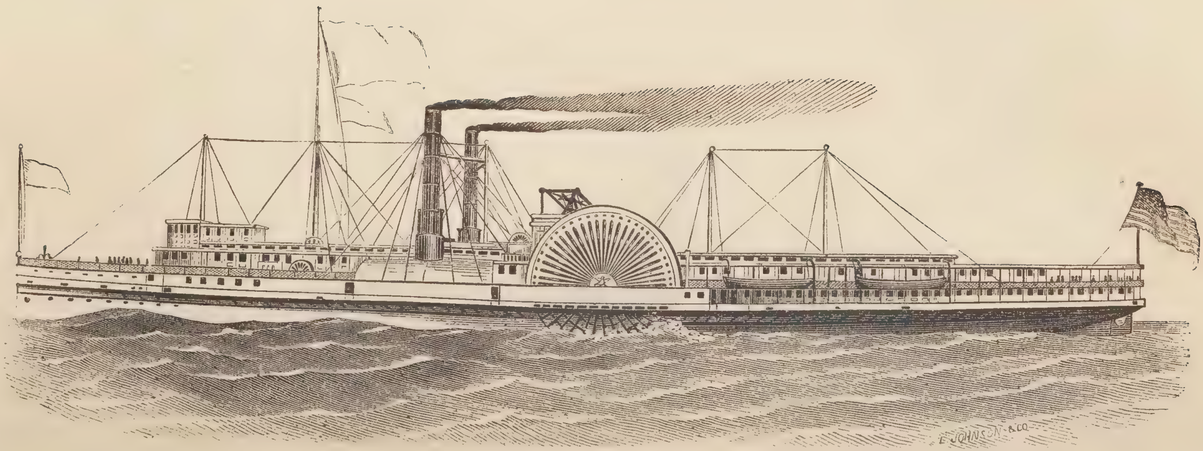
Thus far, therefore, no steamers had ascended the western rivers. The experiment of the Vesuvius had been successful until she ran aground, but it was not conclusive. In 1814 the Enterprise, built at Brownsville, Pa., was provided with one of French's engines, and in December descended to New Orleans. On her return trip, in which she was the first vessel which ascended the Mississippi, she reached Louisville in May, 1816, making the trip from New Orleans in twenty-five days. The event was celebrated by a public dinner given by the citizens of Louisville to her commander, Captain Henry M. Shreve. To this gentleman the West is greatly indebted for securing the free navigation of their waters, for this vessel and another called the Washington, which he subsequently built, were intended to test the validity of Fulton's claims to his monopoly. Both of these boats were seized, as Captain Shreve desired they should be, and the cause being carried up to the Supreme Court, the exclusive pretensions of the monopolists were denied, and the freedom of navigation secured.

The history of the action of state legislatures in aiding monopolists, and the promptness with which the monopolists themselves coöperated with each other, and their willingness to compromise and aid each other, showed how frail is the chance of the public to obtain from their competition the benefits which many theorizers ascribe to this tendency, and afford many valuable lessons for the action of the present generation in contending with other monopolies, which, at times, seem destined to override all the principles of our democratic nationality.

In this way the free navigation of the internal waters of the countries being secured, an opportunity was offered to enterprise, and the result has been beyond what even the most sanguine inventors of this method of transportation could have imagined. Fitch left a request that he should be buried upon the banks of the Ohio, "where the song of the boatman would enliven the stillness of his resting-place, and the music of the steam engine soothe his spirit;" and well has his desire been fulfilled.

The first steam navigation of the ocean was in a boat called the Phœnix, which was launched by John Stevens soon after Fulton's Clermont made her first trip. As Fulton held the monopoly of steam navigation in the waters of New York State, the son of the

AN OCEAN STEAMER.



A HUDSON RIVER STEAMBOAT.

builder of the Phœnix — R. L. Stevens — took her to Philadelphia by the outside passage, the only one then in existence.

The first steamboat to cross the Atlantic, however, was the Savannah, a vessel built in New York, with side wheels and sails. She sailed from New York to St. Petersburg by way of Liverpool, reaching this last named place in twenty-six days, and returned safely. As she was, however, a small vessel, and did not depend entirely upon her engines, her trip was hardly considered a proof that ocean steam navigation was practicable. The first regular passages across the Atlantic were made in 1838 by the Sirius and the Great Western. The first of these left London and reached New York in seventeen days, and the second left Bristol and reached New York in fifteen days.

Since then great changes have been wrought in the models, the construction, and the propulsion of ocean steamers, in which American invention has performed its full share. Though, owing to the conditions of our present tariff, our ocean steamers have entirely disappeared, and there is not a vessel now crossing the Atlantic under the American flag, yet the labors of American mechanics in this direction have left their influence. George Steers, the builder of the yacht America, and of the Adriatic, influenced the lines of all the English sea steamers, as the American models of the clipper ships have modified the rig and the lines of all the best sailing vessels.

The indications are, also, from the success which has attended the use of iron as a material for the construction of sea steamers, and the improvements made in the propeller, or submerged wheel at the stern, that in the future our sea-going steamers will all be built of iron, with water-tight compartments, and, discarding side wheels, be propelled with a screw.

A comparison of the early methods of travel, and of the time and discomfort inherent to the circulation at the commencement of this century, with those now in use, will show in the briefest and most striking manner the industrial advance we have made during the past two generations.

In the early days a sloop would occasionally ply between New Amsterdam (New York) and Fort Orange (Albany), but the license to do so was granted only on condition that she did not carry more than six passengers. From an advertisement clipped from a newspaper issued early in this century we gather that this method was improved somewhat at that time. The announcement reads as follows :—

"SLOOP EXPERIMENT. — FOR PASSENGERS ONLY.

"Elias Bunker informs his friends and the public that he has commenced running a sloop of about one hundred and ten tons burden between the cities of Hudson and New York, for the purpose of carrying passengers only. The owners of this vessel, being desirous to render the passage as short, convenient, and agreeable as possible, have not only taken care to furnish her with the best beds, bedding, liquors, provisions, etc., but they have been at very great expense and trouble in procuring materials and building her on the best construction for sailing, and for the accommodation of ladies and gentlemen travelling on business or for pleasure.

"Merchants and others residing in the northern, eastern, and western counties will find a great convenience in being able to calculate (at home) the precise time they can sail from Hudson and New York, without being under the necessity of taking their beds and bedding; and those in New York may so calculate their business as to be certain of comfortable accommodations up the river."

The time employed in such a trip varied, of course, according as the wind was propitious or not. Nor was the travel upon the western waters calculated to be any more attractive. In 1794 a line of packets, two in number, commenced running between Cincinnati and Pittsburg, and were advertised to perform the voyage, each, once in four weeks; the passengers were assured of their safety, since they would be placed under cover, which was proof against rifle or musket-balls, with convenient port-holes for firing out of. Each boat was to be armed with six pieces carrying a pound ball, and a number of good muskets, with plenty of ammunition.

How few of those who pass up and down the Hudson upon the steamers which will easily accommodate a thousand passengers, or on the Mississippi in one of those floating palaces which will accommodate an equal number, think how much more cheaply, quickly, and conveniently they are thus transported than their grandfathers and grandmothers could have been! It seems impossible that the coming generations shall see changes of equal magnitude; but the world is just waking to the conception of the industrial tendency of mankind, and of the aids that science, combination, and improved social methods can produce.

SHIP-BUILDING.

EARLY HISTORY. — EGYPTIAN, GREEK, AND ROMAN SHIPS. — ENGLISH, SPANISH, AND FRENCH IMPROVEMENTS. — AMERICAN MODELS. — OLD PLANS SET ASIDE. — BALTIMORE CLIPPERS. — THE YACHT AMERICA. — GREAT REPUBLIC. — FLYING CLOUD. — THE BUILDING OF A SHIP. — PROCESS OF CONSTRUCTION. — LAYING THE KEEL. — SETTING UP THE FUTTOCKS. — CEILING AND PLANKING. — CALKING AND COPPERING. — LAUNCHING. — IRON SHIPS. — HOW THEY ARE BUILT. — SUPERIORITY OVER WOODEN VESSELS. — GREATER STRENGTH AND LIGHTNESS. — MORE SPACE FOR CARGO. — WATER-TIGHT COMPARTMENTS. — SECURITIES AGAINST SINKING. — IRON-CLAD FLOATING BATTERIES. — SHIP-BUILDING IN THE UNITED STATES. — DEPRESSED STATE OF THE INDUSTRY.

Ship-building may be said to have begun with the construction of Noah's Ark; but even the ark could only have been an enormous enlargement upon existing models, for from the earliest period, wherever man has lived in proximity to water, boats of some sort have been built. The Hebrew (Scripture) records speak of the joint Jewish and Phœnician naval expeditions for the timber and other material for Solomon's Temple, and mention of "ships" is frequent in the Bible. The oldest tombs and monuments in Egypt bear representations of vessels propelled by means of sails, as well as by oars. Tradition has handed down accounts of great galleys and ships of extraordinary size, used in warfare by the Egyptians, Greeks, and Romans. Cæsar's "Commentaries" allude to ships constructed of oak. Alfred the Great had his navy. Edward III. had ships of war carrying cannon. When the mariner's compass came into use, larger and more complete vessels were built. The discovery of America gave an immense impulse to ship-building in Spain, and that country long took the lead of all other maritime nations in whatever pertained to navigation. The opening of a great East India trade by the discovery of the passage around the Cape of Good Hope, made England foremost among ship-building nations, and under Henry VIII., and especially under Elizabeth, extraordinary progress was made. In

the seventeenth century English ships, of from fourteen hundred to sixteen hundred tons, were built. In the eighteenth century the French so far advanced upon the ships built by the Dutch, Portuguese, English, and Spaniards that their models were eagerly adopted. But with all these nations progress beyond a certain point was comparatively slow, till the United States, ignoring the old-established features in naval architecture, began to build vessels which have since been models for the world.

Speed and beauty were the ends sought and attained in the new American models, and these were secured principally by the introduction of concave, wedge-shaped bows, instead of the convex form, and corresponding "lines" for the stern. The schooners built on Chesapeake Bay, and ships after the style of the celebrated "Baltimore clippers," constructed on the new American model, frequently showed a speed under sail that had not then been attained by the best English steamers. The Collins steamers were the stimulus to the construction of the superb ships the Cunard Company subsequently added to their line. The success of the yacht "America," at Cowes, in 1851, built on the Baltimore clipper model, revolutionized yacht-building in England. Among remarkable American sailing ships, constructed on the new principle, may be mentioned the Boston clipper "Great Republic," of four thousand tons burden, and the "Flying Cloud," which has made three hundred and seventy-four knots in twenty-four hours, or nearly eighteen miles an hour. Other American ships engaged in the California, China, and East India trade, have displayed equally wonderful speed. Assuming, then, that American ships and American models are unsurpassed, we proceed to give the details of construction.

The architect first makes a model of alternate strips of pine and cedar, three or more feet in length, fastened together, and hewn out with the greatest precision, so as to present every line in the ship to be built. From this model he makes three drawings — the "sheer plan," presenting the length, depth, water-lines, and entire side of the ship; the "half-breadth plan," which is a lengthwise section of half the ship; and the "body plan," which vertically divides the ship in halves, and shows the curves and timbers towards the bow and the stern. From enlarged patterns of these plans the workmen select and shape to the required dimensions every timber for the ship.

In the yard, close to the water's edge, blocks are set, — at a

EARLY NAVIGATION OF THE PHŒNICIANS.

THE LAUNCH OF A PACKET SHIP.

proper inclination for the launching of the ship, — on which the keel is laid. Generally a false keel, consisting of pieces of from four to six inches in thickness, and of the same width as the keel proper, — the false keel preventing leeway, and protecting the keel in case of the ship's grounding, — is laid first, and then the keel, of live oak or other suitable wood, and for a first-class ship of timbers twenty inches square, dowelled together to make the required length, is laid. The keel is grooved on both sides to receive the planking. The stern, which must be of the best and strongest timber, and which is backed by other timbers called the "apron" and the "sternson," all securely bolted together, is secured to the keel by a "knee." In setting this very important timber, the greatest care and accuracy are requisite, as any irregularity will be evident in the ship when completed. Next comes the "stern-post" of solid oak, which is mortised into the keel, and is strengthened by an inner post. The backbone of the ship is now ready for the ribs. At each end of the keel the space too limited for framing is filled in with solid timber, known as "deadwood." The floor timbers, with alternate long and short arms, are next let into the keel at right angles, and from the floor are elevated the curved timbers called "futtocks," which make the frame of the ship and détermine its shape. The futtocks are shored up with sticks of timber to keep them in their places. The next process is to lay down the "keelson" — stout timbers running from stem to stern, directly over and securely bolted to the keel, with two or four side keelsons, which are bolted through the floor and futtocks. The spaces between the floor and futtocks below the water-line are filled with timber, and are calked water-tight. The entire frame is then trussed or braced with bands of iron, and the ship is ready for the interior planking, or "ceiling," which begins at the keelson and is carried up the sides. Projecting pieces, called shelves, are placed at proper intervals, and to these the deck beams are fastened with strong wooden or iron knees. Close to the keelson a gutter is left to catch the leakage, if any, and accessible to the pumps. The few planks and timbers which need curving for the ceiling are steamed and bent, and the planks are secured to the futtocks by locust pegs, called treenails. "Breast-hooks" of wood or iron, fitting the shape of the bow, and "crutches" at the stern, are put in to further strengthen the frame. Blocks or "steps" for the mast are fastened to the keelson. The deck beams are strengthened by posts which rise from

the keelson. The outside planking, or "skin" of the ship, is of oak planks, varying in thickness from four to ten inches, carefully selected, and put on with the greatest possible care, as the security of the ship against leakage and decay depends upon the judgment and skill with which this outside planking is performed. The decks, of yellow pine, are framed to leave hatch and ladder ways, mast holes, etc., and are laid with great nicety, so as to be perfectly water-tight, care being taken to put down the planks so as to avoid the possibility of springing or straining. The hatchways are oblong in shape, the broadest part running athwart the deck. The bulwarks are finished; the capstan or windlass, which should be double, running through two decks to enable two sets of hands to work at once, is set; the catheads, to suspend the anchor over the bows, are put in; and much other work is done by the ship-carpenters before the vessel is ready to be calked. The rudder, which may be added before or after launching, is made of the best oak and elm, and is hung by "pintles" to the "gudgeons" in the stern-post. The circular head of the rudder which appears on deck is mortised to receive the tiller, and the tiller ropes run through blocks to a barrel, which turns so as to tauten one rope while it slacks the other from the barrel to the wheel of the steersman.

Calking is the process of making the seams of the deck and the outer planking water-tight, and is effected by driving in oakum with calking-irons, and covering the seams with pitch. Coppering the ship may be done before or after launching, or even after a voyage or two, by taking the ship into a dry dock. The bottom is covered with a smooth coating of pitch and tar, and sheets of copper, four feet in length by fourteen inches in breadth, are nailed on. Patent sheathing is made of sixty parts of pure copper and forty parts of zinc, the zinc counteracting to a great extent the process of oxidation. The coppering is to prevent the bottom from fouling by marine deposits, or the accumulation of barnacles, which materially impede the progress of the ship.

The ship is now ready for launching. At low water, two parallel lines, or ways, of heavy timber are laid the entire length of the ship, and down to the point where the ship at high water will float. On the sliding ways are the "bilgeways," running fiev-eighths of the length of the ship, and connected with the ship by "poppet" and "stopping-up" timbers. These are wedged up with "slices," and the whole makes a cradle, in which the ship is

confined by a single piece of timber called a "dog-shore." When all is ready, the ways are well lubricated with soft soap and grease, the dog-shore is pulled away by a cord, and the freed ship slides down the ways and into the water.

Though now afloat, the ship is by no means ready for sea. Her masts, yards, rigging, sails, cables, anchors, etc., are to be added, and if she is to be a steamer, she must be towed to the works where her engines are put in. With the riggers come the ship-painters and numerous other mechanics, who assist in finishing the vessel and preparing it for sea. The mere building of the hull is but a part — a most important one, however — of an infinity of work that follows.

The woods used in the United States for ship-building are almost exclusively live oak and pine, with such ornamental foreign woods as may be necessary for the cabins. Other nations use a great variety of woods, including teak, mahogany, pencil and red cedar, Spanish oak and chestnut, tamarac, and many others. Masts and spars are made from pine, the larger vessels requiring "made masts" of several pieces secured to a centre stick by iron rings. A full suit of sails for a large ship will use fifteen thousand yards of cotton duck. Anchors — "kedge," "small bower," "working bower," and "best bower" — weigh from five hundred to eighty-five hundred pounds. To prevent the decay of wood used in ship-building, a recent process is to carbonize the surface to a depth that need not exceed one hundredth part of an inch, and which will give a coating that is claimed to be impervious to air and water.

Iron Ships.

Iron now enters very largely into the construction of even wooden ships by the substitution of iron knees, deck beams, and sometimes iron plate (hollow) masts. This use of iron is to secure space, greater strength, and lightness; for a vessel constructed wholly of iron is really much lighter than a wooden vessel of the same size, while by doing away with the space required for heavy timbers, it can carry a much larger cargo. For these and other advantages, iron has come to be a common material for ship-building, and it has been used in the construction of the finest Cunard and other steamers.

For an iron ship, the naval architect sends his construction drawings to the iron plate rolling mill, where each plate is prepared of the exact curve and dimensions. Holes for the rivets

are punched by machinery, and the plates are then ready for the ship-builder. The keel of the vessel is made of iron bars riveted together, and to the iron upright ribs the plates are riveted, one plate overlapping another. The frame of the ship, in which the ribs stand from ten to eighteen inches apart, the outside skin, and indeed the whole structure, are entirely of iron. When the plates are prepared, ships of this kind can be built with great rapidity. They have the advantage over wooden ships of greater simplicity of construction, greater immunity from deterioration, no liability to decay, and they can be built in compartments, which, by making each compartment a floating vessel in itself, immensely increase the security of the ship from sinking in case of collision or other disaster. In rigging, finishing, and otherwise fitting out iron ships, the processes are nearly the same as for ships built of wood.

Iron-clads.

The immense floating batteries, iron ships, and gunboats, lately introduced into the navies of all nations, are constructed either wholly of iron, or they are strongly-built wooden ships, heavily plated with wrought iron, of from four to eight inches in thickness. They carry the heaviest armaments, and are designed, some of them, for sea service, but the majority of them for harbor defence.

Ship-building in the United States.

Ship-building is now (1871) very much depressed in the United States. This is owing to several causes, prominent among them the general use of iron vessels, and the greater cheapness on account of the charges added by our tariff, with which such vessels can be constructed abroad, particularly in Great Britain.

CABINET AND PARLOR ORGANS.

PROGRESS OF MUSIC IN THE UNITED STATES IN THE LAST TWENTY YEARS. — THE MULTIPLICITY OF MUSICAL INSTRUMENTS. — THE ORIGIN OF THE ORGAN, THE INSTRUMENT DERIVED FROM THE "PIPES OF PAN." — CTESIBUS, THE ALEXANDRIAN, INVENTOR OF THE "HYDRAULICON," TWO HUNDRED YEARS B. C. — AN ANCIENT ROMAN ENGRAVING OF THE ORGAN ON STONE. — POPE VITALIAN, AND CATHEDRAL ORGANS. — THE GREEK EMPEROR'S PRESENT TO KING PEPIN OF FRANCE, A. D. 755. — THE ORGAN FROM THE TWELFTH CENTURY UP TO THE FIFTEENTH CENTURY. — DISTINGUISHED BUILDERS OF ORGANS IN THE FIFTEENTH AND EIGHTEENTH CENTURIES. — ICONOCLASTIC OPPOSITION TO THE ORGAN IN ENGLAND, UNDER THE PROTECTORATE OF CROMWELL. — ORGAN MAKING AS AN INDUSTRIAL INTEREST IN THE UNITED STATES. — CABINET AND PARLOR ORGANS. — A SKETCH OF THEIR INVENTION AND GROWTH IN POPULAR FAVOR. — MR. AARON MERRILL PEASLEY AND MR. EMMONS HAMLIN — THE "MASON AND HAMLIN ORGAN COMPANY" THE CHIEF MANUFACTURERS OF CABINET ORGANS. — PARTIAL DESCRIPTION OF THEIR ESTABLISHMENT.

No feature of "progress" among the people of the United States, within the last few years, has been more marked than that of the increased love of music which they display. Twenty years ago, but few *piano-fortes* existed even in the cities, and in the flourishing and important towns. A few harmoniums, melodeons, and other like instruments were to be found scattered over wide territories. The bass and snare drum, the fife, and sometimes a horn of some kind, discoursed the chief music, aside from vocal, which the inhabitants of the interior towns throughout the land enjoyed; and the music of even these was seldom dispensed by their clumsy and unskilled performers, save on militia "training days," and the Fourth of July, or on the occasion of some extraordinary excursion of a civic society from one town on a visit to its brethren in another. The best music of those days — so near in point of time, but so far off on the path of progress — was yielded by the violin, but was generally to be heard only in the "ball-room" of the villages a few times a year at most. The more wealthy of the towns-people were considered

by their neighbors as in danger of contracting extravagant habits in general, — if they were not charged with already having done so — if they indulged in the luxury of a *piano-forte* ; and so marked was the absence of musical instruments among our people at large, that foreigners visiting us, decided that the Americans had but little comprehension of or taste for music, and some of the most refined and observant of our own writers even deplored the lack of interest in music, and the tastelessness and inaptitude of our people to musical studies. This is by no means an overdrawn picture ; yet it would appear so to one considering the condition of things now, and ignorant of the facts which characterized the state of music in this country twenty years ago. What we have said above exhibits the state of music at that time in the Northern and Western states, more particularly than in the Southern. In the last-named states, the "standard" was hardly as high as in the former. Instrumental music was but little encouraged, and the most popular type of vocal music was found in the plaintive airs of the negro slaves. "Dandy Jim from Caroline," "O Susannah, don't you cry for me," and the like, were the most popular songs of the day. To-day there is hardly a town, however far inland, or obscured from the "outside world" by environing mountains, the Green, the White, the Alleghanies, or the Rocky, even, where well-rendered selections from the choicest creations of the grand old masters cannot be heard ; and pianos, melodeons, and cabinet organs are to be found, all over the country, in the brown clapboarded houses, the tenants of which do not feel able to paint them,— such is the spirit of the love of music with our people now. And this, as already intimated, has created an industrial interest of great magnitude.

The origin of the organ is lost in the night of the past. The name is derived from the Greek *organon,* which signifies simply an *instrument* of action or operation, by which some process is carried on, and, as applied in the mechanics of music, covers several instruments the principles of the construction of which are somewhat similar. The largest of these is the church organ, which is usually understood to be meant, when the single, unqualified word "organ" is alone used. This has come with the "growth of the ages," step by step. The hypothesis generally received as well founded is, that the organ, in its simplest state, was a modification of the "Pipes of Pan," or simple hollow reeds of various lengths, bound together and so arranged as to be rapidly

swept over by the mouth of the player, each pipe graduated as near as might be to some natural "note" of music. But the steps of improvement of the original organ are all lost to us so far as the relative times at which they were taken are concerned. But that the progress of this instrument was slow is sufficiently certain. Eventually, the mechanical powers of water came to be understood, and as early as two hundred years before Christ, it is said that Ctesibus, the Alexandrian, inventor of the *clepsydra*, or water clock, also invented an *hydraulicon* or hydraulic organ. Upon an ancient monument in the *Giardine Mattei*, at Rome, was carved an organ, parts of which bore strong resemblance to the organ of these times. St. Augustine in his scriptural comments, makes allusion to the organ; and it is related by some writers that Pope Vitalian, during the last half of the seventh century, promoted the introduction of the organ as an inspirer of devotion into some of the chief churches of Western Europe; and we have reliable account of an organ having been presented to King Pepin, of France, in the year 755, by the then ruling Emperor of Greece.

It is confidently declared that organs were "common" (by which term we suppose, however, that nothing more is intended, than that a few existed) in England, in the tenth century. It appears that these were generally quite large — larger than those then to be found on the continent. Elfeg, Bishop of Winchester, caused one to be set up in his cathedral in 951. These organs were coarsely constructed, and of restricted capacity. The keys were struck with the fist, and the pipes were wholly of brass. Twelve pipes, or fifteen pipes at most, measured the capacity of the largest organs, up to as late a period as the twelfth century. Eventually, some Italian inventor added half notes, and first introduced his improved organ to the Venetians. This was near the close of the twelfth century. Pedals, or foot-keys, came not till as late as 1470, and were the invention of a musical German mechanic by the name of Bernhard. But some time elapsed after this before the organ reached its present form.

Of the builders of organs, the names of whom have been most noted, may be mentioned the Antegnati, of Brescia, in the fifteenth and sixteenth centuries — later, in the eighteenth century, Serrassi of Bergamo, and the Venetian Callido.

The organ, like almost everything else of mechanical progress, has had its history of opposition. In England, during the existence of the commonwealth, under the protectorate of Cromwell,

the iconoclastic spirit of the Puritans vented itself upon many of the largest organs in England, as idolatrous, or, rather, barbarous and unchristian in their nature, — being mechanical aids to devotion, which should be, as they declared, wholly spiritual in its character and means of expression.

But we have not space to pursue the history of the organ in its details of construction, and its steps of progress of growth in popular favor, for the last few centuries, — nothing of which, however, is specially remarkable, save within the last few years.

One form of the organ — cabinet and parlor organs — is very rapidly gaining in popularity and use in the United States.

In 1870 about thirty-two thousand were made and sold in America, while the number of piano-fortes was about twenty-three thousand. The increased use of organs within a few years has been very great. Probably their sales ten years since were not more than one-third what they now are. This is undoubtedly owing in a large measure to the great improvements made in the instrument itself. Formerly it was a mere "convenience" for lack of something better, and mainly because nothing more satisfactory was available. Now the instrument is worthy from its intrinsic merit, and has favor with cultivated musicians, as well as the people. There can be little doubt that it has not yet reached its greatest popularity, because not sufficient time has yet elapsed to make it generally known, and its practical advantages are so great. It is comparatively very cheap. A good instrument, though quite small, is now furnished at fifty dollars; and from this it increases in size, capacity, elegance, and price, to styles which are worth thousands of dollars each. Thus it is adapted to a wide variety of means and classes of purchasers. Room can be found for the smaller styles, where there is not sufficient space for larger instruments; and the larger styles admit of the greatest amount of elegance in form and decoration.

Reed instruments, of which these are now the best illustrations, and the only ones largely sold in America, include melodeons, harmoniums, seraphines, and all instruments producing tones by free reeds without the use of pipes. The reed is a thin strip of brass or other material, from half an inch to several inches in length. It is fastened at one end over an aperture in a metal plate, corresponding in size to the reed. A current of air is made to pass through the aperture, causing the reed to vibrate and produce a musical tone. The size of the reed determines its pitch, and its

shape, surroundings, and a hundred conditions, determine its quality of tone. The invention is an American one, letters patent therefor having been granted to Aaron Merrill Peasley in 1818. The original papers, signed by James Monroe, President, and John Quincy Adams, Secretary of State, are now in the possession of the Mason and Hamlin Organ Co., of Boston and New York. Mr. Peasley styled his invention "an improvement in organs." At first, the new instrument enjoyed, and probably deserved, little popularity. Doubtless the quality of tone produced was so poor as to make it rather an instrument of torture, than anything else.

About twenty-five years after, Mr. Jeremiah Carhart, then in Buffalo, N. Y., introduced improvements which seem to have first given the instrument currency. He employed an exhaust bellows instead of the force bellows which had commonly been used before, and in other respects somewhat modified its construction.

Mr. Carhart was evidently not the originator of the exhaust bellows; for in the original claim for the patent, Mr. Peasley had stated that a force or exhaust bellows might be used. But Carhart seems to have been the first to use the latter in such a manner as to develop its advantages, which were chiefly in improved quality of tone. He gave his instruments the name "melodeon," by which they became widely known, and are familiar to most readers.

A few years later Mr. Emmons Hamlin, now of the Mason & Hamlin Organ Co., but then quite a young man, in the employ of Messrs. Prince & Co., of Buffalo, introduced an improvement, which has probably done more than anything else to render the instrument worthy of its present popularity. He discovered that by giving to the tongue of the reed a slight bend and twist, the quality of tone was greatly modified. Patient and skilful experiment led to the development of the art of "*voicing*" reeds, which was immediately introduced in the instruments of Messrs. Prince & Co. It gave them great superiority, and they speedily became the largest manufacturers of this class of instruments in the country. Other makers were not long, however, in discovering the secret and adopting the improvement, which has now become universal. Few, if any, instruments of the class are now made in this country without voicing the reeds.

Mr. Hamlin seems to have had from the first, and not to have lost it, great zeal and capacity in the construction and improve-

ment of musical instruments. In illustration of this may be mentioned the recent construction by him — as a matter of personal gratification solely, and with no reference to business — of several violins, which are said by *virtuosi* to be of extraordinary excellence, and to need age only to rank with the productions of the old masters, who, it has been supposed, had left no successor to their skill.

A few years after his discovery of the art of voicing reeds, Mr. Hamlin, feeling confident that great improvement was yet possible in reed instruments, and finding others possessing the same confidence, became associated in business with Mr. Henry Mason, a son of Dr. Lowell Mason, the distinguished musical composer and author, under the now well-known name Mason & Hamlin, for the manufacture of instruments of the class. Combining, thus, musical cultivation with mechanical skill and experience, in this specialty they united, what is not common, a knowledge of what results were desirable, and capacity for their production.

The new firm gave themselves at once to experiment, which has been perseveringly pursued to the present time; and they have certainly been largely successful in that improvement which has raised the instrument to its present popularity. To follow in detail the improvements which they have effected would occupy more space than can here be afforded. Allusion may, however, be made to the employment of an improved bellows, having two blow-pedals, and giving a much stronger current of air than was before available; the introduction of ingeniously constructed valves, which are important in securing more nearly perfect and durable action; of the automatic swell — a device as simple as effective; of new and different scales for sounding and tube boards; the discovery and application of principles effecting the purity and power of tone. The instrument has indeed assumed a new form, both in interior and exterior, and its relationship to the melodeon with which Messrs. Mason & Hamlin started is hardly nearer than was that of the latter instrument to the accordeon, which preceded it.

The growing popularity of reed-organs has stimulated efforts by others also, by whom some improvements of value have been originated; but the Mason & Hamlin Organ Co., as in the growth of its business it has become, have undoubtedly been the leaders in the march of improvement, and have accomplished most important results. Their instruments possess a peculiar excellence

in quality of tone, which is highly appreciated by musicians; the result, in a measure, undoubtedly, of superior "voicing" — an art in which they are acknowledged to excel. Apace with the reputation of their work, the demand for the organs made by the Mason & Hamlin Organ Co. has increased. They are now much the most extensive manufacturers of this class of instruments in the world, producing more than twice as many as any other maker. Recently they have added a large new factory to their premises, but are still greatly in lack of sufficient facilities to supply the demands for their instruments.

The reader, if he can obtain permission to go over it, will find much to interest him in the principal factory of this company, at the corner of Cambridge and Charles Streets, Boston. Machinery is largely employed, resulting in more exact and better work, and greater economy of cost. Every part of the instrument is made by this company themselves, and every precaution used to secure only the best and most reliable work.

The works of the Mason & Hamlin Organ Co., are, without doubt, the largest establishment of the kind in the world; and as such, merit, together with the successes of the company itself, and their peculiar advantages as manufacturers of cabinet and parlor organs, a brief historic notice in a work like this.

The company originated about eighteen years ago, under the firm name of Mason & Hamlin. Its factories are at the corner of Cambridge and Charles Streets, Boston, and in Cambridge, Mass., covering an area of seventy by three hundred feet, five stories high. The Cambridge factory has the advantage of a railroad track connected with all the railroads centering in Boston. The salesrooms are at 154 Tremont Street, Boston, and 596 Broadway, New York.

The number of workmen employed is about five hundred. The capacity of the establishment is two hundred organs per week. None but first-class organs are there made, and they range in price from fifty to fifteen hundred dollars each. They are sent to every quarter of the globe, viz., throughout the American continent, to Europe, Western Africa, to Japan, China, and Australia — wherever the English language is spoken, and where it is scarcely known; in fact, to all countries where the love of music is cultivated. Their exportation to Europe exceeds $100,000 in amount annually. It has been carefully and curiously estimated, that if all the organs made by this concern in the year 1869 (and

the number in 1870 was considerably larger still) were stretched out, end to end, in a continuous line, they would reach to the distance of three miles; or they would form a wall nine feet high, sufficient to enclose the whole of Boston Common.

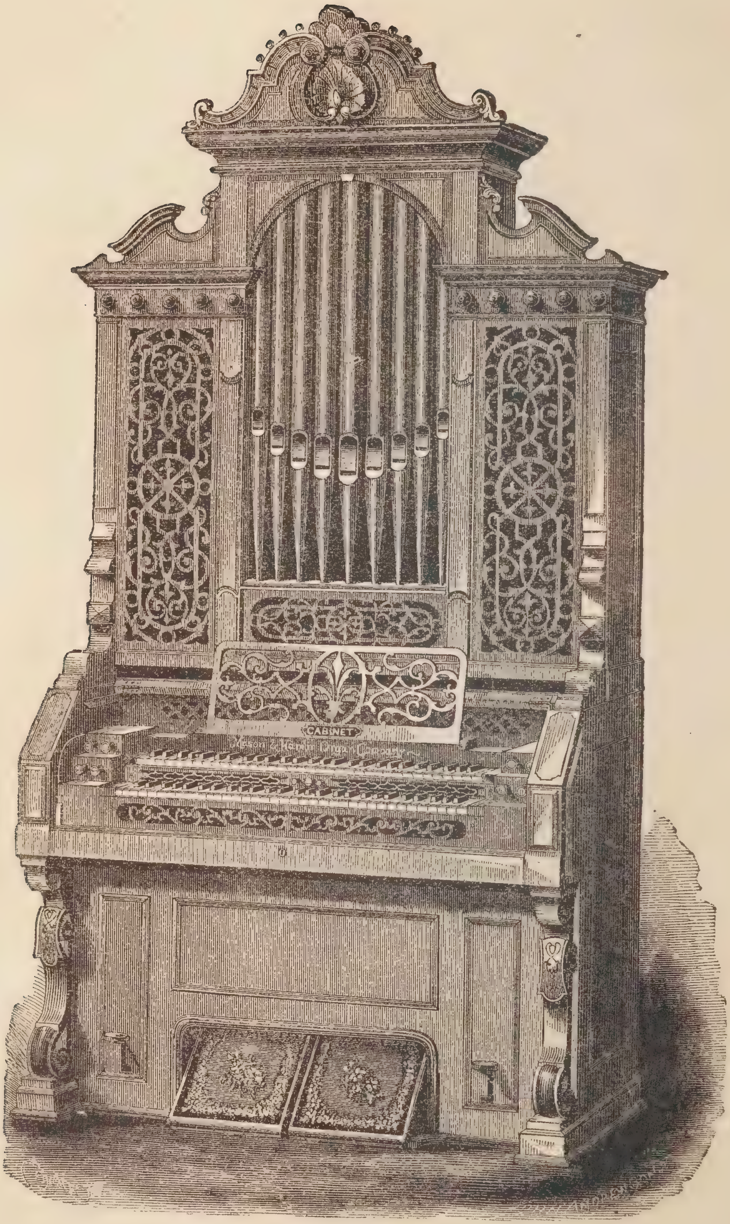
The Mason & Hamlin Organs were awarded the American medal at the Paris Exposition, but two other medals then being awarded, one to Germany and one to France. They have also won seventy-five medals, or other first premiums, at various Industrial Exhibitions in America. They are used in preference to all others in concert-rooms, by the most eminent artists, a majority of whom, here and in Europe, have given voluntary written testimonials to their numerous superior merits. In fact they are recognized as the standard of excellence.

It is everywhere to be noted in the history of a great manufacturing enterprise of any nature, that its great success depends upon compliance with the laws of rigid industry, perseverance, and the conscientious production of the best wares, as well as honorable, fair dealing with customers; and it is fitting, in merited compliment to this distinguished company, to say that the superiority of their organs is owing to the following reasons: The long experience of the proprietors; the vast amount and great variety of ingenious and latest improved machinery, tools, and appliances; the adoption of all improved processes in the preparation and manufacture of the materials; the introduction of all valuable new inventions in the mechanism; the employment of workmen who have been thoroughly bred to the business; the employment of each set of workmen only upon one special branch of the work, so that each attains perfection in his particular division of labor; the fact that the foreman of each department is made peculiarly responsible for any defect which may occur in his department; the unequalled care observed in thoroughly seasoning materials; and the admirable system in putting together, with exactness and nicety, the three to four thousand pieces of wood, iron, brass, ivory, ebony, leather, rubber, cloth, and other materials necessary to the construction of a perfect organ; all of which discloses not only the best business good sense, but high-toned professional ambition, which it is ever so pleasant to record of our leading manufacturers in general.

The large scale upon which these organs are made, and the possession of every facility which ingenuity could devise or money purchase, enable this company to furnish these first-class instru-

CABINET ORGAN.

Length, 4 feet. Height, 8 feet. Depth, 2 feet. Weight, 278 pounds.



CABINET ORGAN.

Length, 4 feet 8 in. Height, 8 feet 4 in. Depth, 2 feet 5 in. Weight, 362 pounds.

ments at the lowest rates; as low, in fact, as the rates charged for inferior instruments made by others. The company make all parts of these instruments themselves, and thus avoid the necessity for charges to cover the two or three profits which are made when the parts must be purchased, as is the case with smaller manufacturers.

Some peculiar reasons, which may properly be pointed out, have materially tended to give the organs made by this company the popularity which they enjoy, and illustrate, at the same time, the vast improvements which the organ, since the days of simple Pandean reeds form, has undergone. The action of the *improved centre-pressure self-adjusting reed valves* is more instantaneous, sure, and perfect than that of any others. The pressure on all parts of the valve-seat is exactly equal, and perfectly closes the aperture; and therefore the tones do not sound when the keys are not pressed down. These valves insure a lighter action, employ a more forcible current of air, produce a complete vibration of the reed, increase the volume of tone, improve its quality, and give better capacity for expression. In the construction of the *sounding* and *tube boards*, the materials, size, plan, and details are such that these organs have become specially famous for musical power and sonorousness. The new styles of *resonant cases* also aid in rendering the tones peculiarly full and rich, giving them perfect vibration. The *automatic bellows swell* far exceeds all others in producing *crescendos* and *diminuendos*, and is more effectively used with little practice. The tones by its use, from the loudest to the softest, are commanded to any degree without any unusual movement of hands or feet. This swell is perfectly simple in construction, and least liable to get out of order. It has received many medals, and the high approval of judges, at the Paris Exposition and elsewhere. Numerous fruitless attempts have been made to imitate it. The Mason & Hamlin *Improved vox humana* produces brilliant orchestral and solo effects, giving a remarkable imitation of stringed instruments, and a near resemblance to the best characteristics of a cultivated *human voice*, from which it takes its name. It is as durable as the instrument itself, being simple in mechanism. It is a combination of several patents, is used only in these organs, and is one of the most popular improvements ever introduced. *Wood's octave coupler* is used in these instruments, and doubles their power. It enables the performer, by touching any one key, not only to produce all the

tones immediately connected with it, but also their octaves. It is not liable to get out of repair, which cannot be said of other couplers. The *vibrators* or *reeds* are made by peculiar machinery, invented and perfected by the company itself. Each reed is afterwards carefully finished by hand, thus securing a uniformity unattainable when the reed is made wholly by hand or less perfect machinery. No reed is stamped out of brass. Every one is riveted with iron, thus securing strength and durability.

The liberal policy of this company in patient and costly experiments, and in obtaining, at whatever cost, the use of every real improvement made by others, has given them the control of the most important improvements. Many are patented, and exclusively used by this company, although some other makers wrongfully represent their instruments to be the same.

Every Mason & Hamlin organ is rigidly tested before being suffered to leave the establishment, and each instrument is warranted in the amplest manner for five years. Their points of superiority are thus summed up, as claimed by the company: Superior quality of tone; power and volume of tone; capacity for varied effects, imitating pipe organs, the violin, violoncello, horn, flute, clarinet, etc.; capacity for expression; quickness of utterance, having almost the vivacity and life of a fine piano-forte; uniformity in character, and equality in loudness of tones, throughout each stop; quality of keeping in good tune; smoothness and perfection of action, all the mortises in the keys through which the guide-pins work being lined with cloth; and in other respects they are so constructed that the action may be reasonably expected to be smooth and noiseless till worn out; durability: when carefully used they may be expected to improve for years. They are used in many countries and most trying climates; all the nicest parts of the lumber are seasoned for years in the open air, then in drying kilns, and then by a new process of superheated steam. They scarcely ever require tuning. They can be sent anywhere, ready for use, and without risk, by the ordinary freight routes, etc. Strength and thoroughness of construction: these merits of the Mason & Hamlin organs are illustrated by the following facts: the desks are all made of three pieces of wood, so glued together that the grain runs in different directions, securing the greatest possible strength. The stops have fronts of engraved ivory. The ivory in the keys is of the best quality, and the fronts of the keys are of ivory instead of wood. The

black keys are of ebony, not painted inferior wood. The pedal coverings, hinges, locks, etc., are of the best quality; and every other detail exhibits the same thoroughness of construction and strength of material.

The claims to preëminence of the Mason & Hamlin organs are confirmed not only by the large number of premiums they have taken within a few years at all the prominent fairs, but also by the Internal Revenue returns, which are made under oath, and show that their sales are very much larger than those of any other reed instrument. More than three hundred of the most prominent artists of the United States, and many of the leading organists of Europe, besides the most eminent musical and other journals of both hemispheres have testified to the superiority of the Mason & Hamlin organs; and independent of their numerous other merits, in any of their great variety of styles they are chastely elegant specimens of furniture, worthy of a place in the most sumptuously furnished apartment.

In listening to these organs one feels the full force of those lines of Tom Moore, in his "Loves of Angels," in regard to the connection between love, religion, and music; and notwithstanding the prosaic character of an article upon an industrial enterprise and manufacture, we conceive it not unfit to conclude it with the lines above referred to: —

> "O Love, Religion, Music, all, —
> The only blessings since the Fall, —
> How kindred are the dreams you bring!
> How Love, though unto earth so prone,
> Delights to take Religion's wing,
> When time or grief hath stained his own!
> How near to Love's beguiling brink,
> Too oft, entranced Religion lies!
> While Music, Music is the link
> They both still hold by to the skies,
> The language of their native sphere,
> Which they had else forgotten here."

AXES AND PLOWS.

THE PRIMITIVE AXE. — ITS USE AS A WEAPON OF WAR. — THE POET WHITMAN. — IMPORTANCE OF THE MANUFACTURE OF AXES IN THIS COUNTRY. — THE CHIEF MANUFACTURERS, COLLINS & CO., — THEIR VAST ESTABLISHMENT AT COLLINSVILLE, CONN. — MODE OF MANUFACTURING DESCRIBED. — PLOWS, ANCIENT IMPLEMENTS. — THE PALESTINE, CHINESE, EAST INDIA, AND OLD NORMAN PLOWS (ILLUSTRATED). — THE PLOW IN MODERN TIMES. — PROCESS OF MANUFACTURE OF PLOWS. — COLLINS & CO 'S SUCCESS, WITH REASONS THEREFOR. — OF FUTURE PROGRESS, AND THE PART THE AXE AND THE PLOW MUST CONTRIBUTE THERETO. — THE "REVOLVING COULTER" PLOW. — SUNDRY ILLUSTRATIONS.

The needs of man must have made some means of severing the branches from trees, and breaking up the soil, among the earliest of tools — the most primitive of manufactures. Mere brute force could break the small limbs of trees, and the heel, or a stick pushed by the hand, could tear up the sod a little; but as soon as man came to emerge from the most savage state, he needed some instruments like those of the axe and the plow. Among the fossil and other remains of the oldest nations we always find some instrument similar to the axe — the bone and stone tools of sundry aboriginal races of America; and sometimes the metallic instrument, made of copper blended with tin; the tools with which the ancient Etruscans cut even porphyry (when the mode of hardening tools must have reached its highest perfection, since porphyry is the hardest of all minerals); the copper axe of the Druids — all these assure us of the primitive use of the axe and its co-relations.

The axe, in ancient times, was used for warlike as well as domestic or civic purposes, and bears more historic stains of human blood than any other domestic implement. The poets have not only sung the praises of the woodman's peaceful axe, but have sounded those of the barbaric battle-axe. But neither historian nor poet of the past knew a tithe of what the writers of to-day might say

of the marvels wrought by the axe, as a pioneer of civilization. The poet Whitman, in his quaint, peculiar, nerveful style, has given the axe a classic niche in the temple of poesy. We quote a few lines from his "Broad-Axe Poem": —

> "Broad-axe, shapely, naked, wan!
> Head from the mother's bowels drawn!
> Wooded flesh and metal bone! limb only one and
> lip only one.
> Gray-blue leaf by red-heat grown! helve produced
> from a little seed sown!
> Resting the grass amid and upon,
> To be leaned, and to lean on.
>
> . . . . .
>
> The axe leaps!
> The solid forests give fluid utterances;
> They tumble forth; they rise, and form
> Hut, tent, landing survey,
> Flail, plow, pick, crowbar, spade,
> Shingle, rail, prop, wainscot, jamb, lath, panel, gable,
>
> . . . . .
>
> Capitols of States, and Capitol of the nation of States.
> Long, stately rows in avenues, hospitals for orphans, or
> for the poor or sick,
> Manhattan steamboats and clippers, taking the measure
> of all seas!"

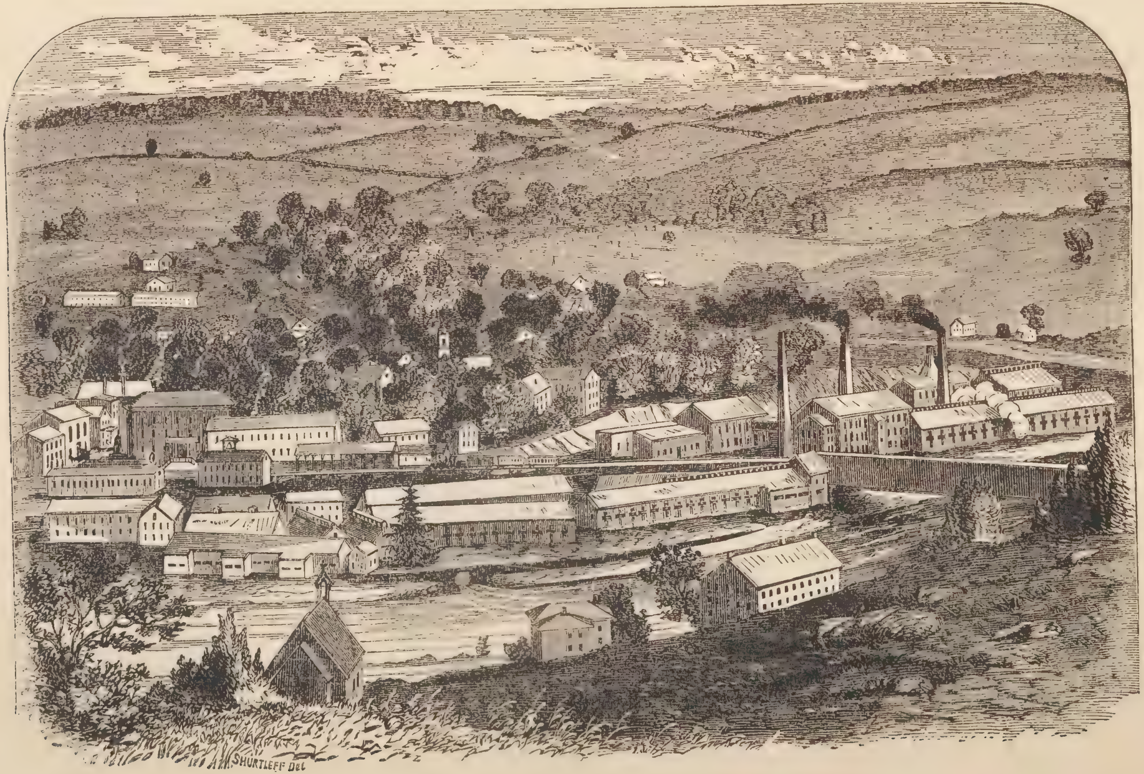
The manufacture of axes in this country constitutes one of our largest and most important business interests, involving an immense amount of capital, invested in several (in fact, in nearly all, to a greater or less extent) of the States of the Union, and employing a vast number of laborers. But the axe is an implement which requires far more science and skill in its manufacture, where a perfect instrument is intended to be produced, than not only the cursory thinker, but even the actual observer of the process of its manufacture would be apt to consider; so much depends upon the amount of pressure the steel may receive under the hammer or press, its degree of tempering, and many manipulations which it undergoes in its various phases from the crude elements, or till it is pronounced finished. Therefore the merit of various axes of different makers, though made from the same kind of materials (iron and steel), from the very same manufacturers of these, even, is as varied in degree as the makers of the implement are different in person. It is a mattter, therefore, of great importance to the consumer, or wielder of an axe, that he possess himself of the best made one. All other things being equal, it is usually safe to

say that the wares of those who have, against all obstacles, and commencing with limited means, worked out for their wares a large sale, or a wide-spread fame, are the most confidently to be trusted; for, in such case, the valuable character of the wares themselves accomplishes the success of their makers.

There are numerous manufacturers of axes in this country, not a few of whom do excellent work; while others, a very numerous class (it is an unpleasant thing for the writer to confess), are satisfied with making and putting upon the market, in the shape of an axe, anything that will sell; trusting to a little cheaper price, as the attraction to buyers, — who, however, always find that "cheap tools are dearest." But in the matter of chief excellence and extent of manufacture of the axe in this country, it is fortunately not left for the writer of this article to decide; for, turning to that grand repository of useful learning, "The New American Cyclopædia," published by the Messrs. Appleton, it will be found (vol. ii. page 422, issued in 1859) there stated, that "the largest establishment in the world for manufacturing axes and edge tools is that of Collins & Company, situated on the Farmington River, at Collinsville, Connecticut." Since that time this company has steadily increased in business power and facilities, and in the extent of its manufactures has more than held its relative position in regard to other manufacturers; and the encyclopædist above quoted, were he writing of the same company to-day, might add, that as manufacturers of plows, also, they stand unrivalled in this country, and, it is believed, throughout the world.

Perhaps, then, we cannot better serve the general reader, who would learn how axes are made, the processes through which the iron and steel are passed, etc., etc., than by taking him through the establishment of Collins & Company, and pointing out to him the chief important processes. The engravings with which this article is illustrated will give the reader who may be unacquainted with the manufacture of heavy materials a fair understanding of the vast power and labor it takes to convert iron in the raw state, not only into axes, but a thousand other things in daily use.

But here it is fitting that we give a partial history of the up-growth from its infancy of the vast establishment, and the powerful corporation of Collins & Company, a growth peculiarly American, and which, resting upon axes and plows, as it does, could never have occurred in any part of the world but the United



COLLINS & CO.'S WORKS, COLLINSVILLE, CONN.

States; and this success has been achieved by true merit, commencing, as will be seen from what follows, with a "small beginning." The reader will reflect that the union of two of the most abundant substances in Nature, iron and carbon, produces steel; and but for this union the world would be without all products and results whatever which are achieved by the use of cutting-edges. Iron alone would have given mankind only a sort of half-civilization. The union of these two substances is not natural, but artificial, and is a matter for the best skill; if too soft, the steel will not receive a keen edge or retain stiffness; if too hard, it breaks. The proper compounding of iron with carbon, the process of nicely tempering to just the right hardness, and the most approved methods of manufacture, make up the business of tool-making as carried on in the village of Collinsville, Connecticut.

The vanguard of American civilization moving westward has always been armed, as nobody needs to be reminded, with the axe. This tool, indispensable, although too unsparingly used against the trees by almost every original settler, was roughly hammered out by blacksmiths, forty years ago, each purchaser grinding his own to an edge. More than forty years ago, Mr. Samuel W. Collins, at that time engaged in mercantile business in the city of Hartford, Connecticut, convinced that there was a field of American enterprise in the manufacture of axes, determined to commence in a small way in a little stone shop, still standing among the score of larger ones which have since gathered around it. Mr. Samuel W. Collins afterwards removed to the town of Canton (the chief village and business part of which has long been named Collinsville, in honor of him), and the business has since been his life-work, and his name is known wherever tools are used. He is living yet, and his quaintly-written diary shows all the shrewd, hard sense, ingenuity, and practical sagacity which characterize the New Englander. The following memorandum is taken from this diary: —

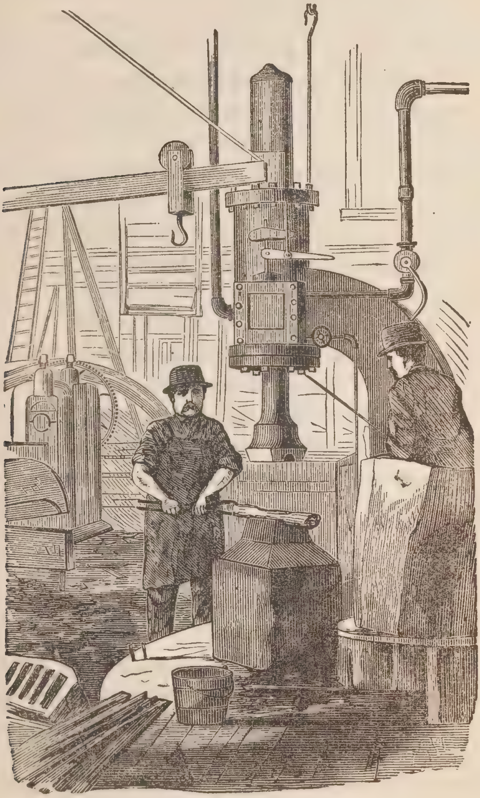
"1828. — Contracted with Oliver Couch to take his four-horse stage off the Albany turnpike, and run through Collinsville to Farmington and Hartford, and so got a post office established at Collinsville. . . . Built the first trip-hammer shop, etc. Commenced drawing axe-patterns, and making broadaxes with trip-hammers. Each man tempered his own, forging and tempering eight axes per day."

We have not space to recite further from the diary, showing the increase of business step by step, on up to this time.

From this insignificant beginning, a few men making each eight axes per day, the business has grown, in forty years, into a stock company, with an invested capital of over a million, employing over 600 men, producing 3000 axes and tools per day, with a capacity for producing daily 100 plows in addition to the other work. The annual sales are over a million of dollars; the annual consumption of anthracite coal, 10,000 tons; of charcoal, 50,000 bushels; of steel, 1100 tons; of iron, 5000 tons; and of grindstones alone, 600 tons are literally ground away in powder.

The first process at the works of Collins & Company is to make the steel, for all their tools are made on the spot from the first stage to the last. The steel-making process is simple. Bars of the best Swedish iron are placed in trough-like furnaces, made of fire-slabs, and enclosed in a shell of fire-brick, in alternate layers of iron and pulverized charcoal, care being taken to prevent any contact of the bars; when the furnaces are thus filled, the whole is tightly sealed up, and the "heat" is commenced. Twenty tons of iron are prepared at a "heat;" five days are spent in preparation, nine in keeping a perfectly uniform temperature of a thousand degrees, and five more in cooling. When removed, the iron has become what is known as "blistered" steel; the carbon has penetrated it, roughening the surface, and puffing it up into little blisters. The texture of the iron bars had a grain, like wood; they were fibrous, and would bend easily without breaking. They are now crystalline, and very porous; the increase in bulk is such, that repeated "heats" have made long cracks in the thick walls of the furnace, which are strengthened by careful bracing. This blistered steel, now so brittle that a slight blow snaps it like clay, is the material from which, forty years ago, country blacksmiths hammered the imperfect axes which cleared up the new settlements. It is unmistakably steel, but is not homogeneous; the carbon has penetrated it, but is not evenly mingled with it, and the next process is to make of it "cast" steel, — as many a soft iron tool is falsely represented to be by the stamp upon it. Broken into small pieces, the bars of blistered steel are placed in crucibles holding fifty pounds each, made of plumbago and clay, and resembling in shape an earthen butter-jar; these are set in furnaces built under the floor of the foundry, and subjected for four hours to a heat of 2760 degrees, after which their contents are cast into ingots, or round bars about a yard long.

The next process is hammering, the object of which is to compress the steel, increase its toughness, fineness, and tenacity. This is done under the steam-hammer, borax being used to cement into union any parts of the ingot which may be partly separated by flaws. From the hammer, the ingot passes to a series of rollers, and after leaving them, further hammering is applied, until



VIEW OF THE STEAM-HAMMER.

the ingot becomes a bar about ten feet long. Its tenacity and closeness of structure, as well as its uniformity, have been marvellously increased by this hammering and rolling, and the bar is now ready to assume the rough form of the axe-bitt, or cutting part. Common as the axe is, some may not know that it is made in two parts, a "poll," or head of iron, and a "bitt," or cutting

part of steel; the place where these are joined may be recognized by a faint line about three inches from the head of the axe. The iron head is shaped by machinery, and is made solid, that is, the hole for the handle is punched instead of being formed by welding. The heated bar is inserted in an aperture in the machine, whereupon a gigantic knife snips it off at the required length; next a pair of dies give the iron the proper fold or bend; the workman withdraws the lump of iron, inserts it in another aperture, and the hole for the handle is punched; another movement, and it is bent in the opposite direction, and so, by rapid and successive compressions, the head is shaped, and ready to receive the bitt. This bitt, hammered from the steel, and finally punched by a die into shape as long as the axe is to be wide, with a broad flange left on either side, is now ready to be joined to the iron poll, and complete the form of the axe. The steel bitt is inserted in the iron poll, both being properly heated; the forger turns over the two flanges of the poll upon the bitt, then runs with it to a trip-hammer, under which, by alternate heating and hammering, the two parts are so firmly welded together as to be practically one. When sufficiently drawn out under the trip-hammer, the next process is to reduce the thickness by grinding; this labor, however, which is slow, expensive, and unhealthy for the workmen, has been greatly lessened by the introduction of machines which now actually *shave* down the bitt of the axe nearly to an edge.

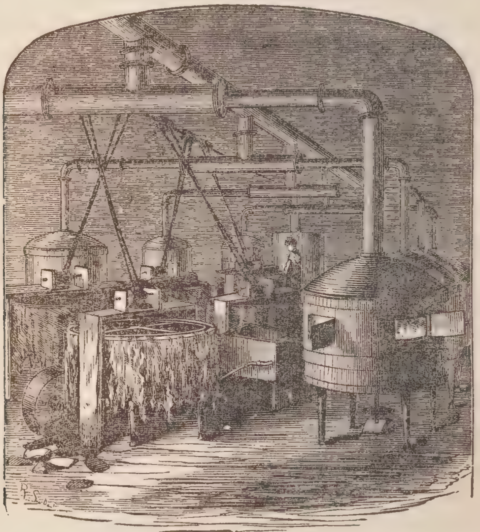
The axe now goes to the tempering-room, where one of the most interesting of all the processes is carried on; any defect in tempering would be utter failure. The old way consisted in heating axes, a few at a time, and plunging them into cold water, thus making the degree of temper a matter of accident and conjecture. In these works, on the contrary, a hundred axes are heated at once, being placed on the edge of a circular drum, with the bitts projecting over the edge, the bitts being the only part it is desired to heat. This drum is contained in a circular iron oven, and the fire laps up against the bitts of the axes as they project over the edge of the drum, while, to secure perfect uniformity in heating, the drum itself slowly revolves. The cooling-bath stands close by, filled with a fluid preparation composed of salt and other substances. On the top of the bath is a frame, which, as well as the bath itself, is circular, and is fitted with hooks around its edge; on these hooks the axes, taken at the proper heat from the

furnaces are hung by the hole made for the handles, so that the bitts are immersed in the bath, and the frame, steadily revolving, drags them around through the water.

The "temper" is now in; but there is far too much of it, and in its present condition the axe would be as useless as if made of glass. It is impossible by merely heating and plunging in cold water to attain the desired degree of temper — the only way is, to make the axe very hard, and then soften it to just the right point. For this purpose the axe passes on to the drawing-furnaces at the other end of the room; there are but two of these furnaces, but they hold two hundred axes each, and can temper over one thousand each per day. They are circular ovens, containing each two racks, revolving only as they are turned by the hand, on which the axes are hung, and again slowly heated, this process *drawing out* a portion of the temper or hardness previously acquired. The philosophy of the process is briefly this: hardness is but another name for density or closeness of structure. The axe, when its particles are separated by heat, being suddenly cooled, the caloric is expelled so suddenly that the particles are *rushed* together in excessive compactness, and the steel is thereby made too hard; the subsequent gentle heating slightly separates the particles again. The workman judges of the proper temper partly by the color the metal assumes, and partly by certain indescribable signs and instincts his practice has given him. A "pigeon-blue" is the desirable shade. (The very deep blue on some articles, such as gun-barrels and watch-springs, is put on artificially, and is merely on the surface.) Some methods of tempering follow the color entirely. Thus, a brownish yellow, corresponding to four hundred and ninety degrees, is thought right for cold-chisels; tinged with purple, five hundred and ten degrees, for plane-irons; purple, five hundred and thirty degrees, for table-knives and scissors; pale blue, five hundred and fifty degrees, for swords and watch-springs; while at six hundred and thirty degrees, all color vanishes, and the steel becomes soft as iron.

Testing is next in order; and for this, two or three axes out of each lot that comes from the tempering-furnace are ground abruptly to an edge. Here is one just from the bath, not yet drawn at all; touch its edge with a hammer, and it flies off like glass. The enthusiastic superintendent, who accompanies us, exclaims, "Beautiful steel!" and even the unpractised eye can see that it *is* beautiful — that broken surface, with its light gray tint, its smooth crystal

lustre, and its marvellously *fine* structure ; but for this steel it is hard to say where our modern civilization would be. The apparent difference between the hard and the properly tempered steel is in a slight variation of color, the latter suggesting more than the former — the notion of being alive and active. The tester lays the edge of the axe over an anvil, and taps it gently with a hammer. If it first bends a very little, and then breaks off short and sharp, it is right ; if it bends too far before breaking, it is too soft ; if it snaps off too soon, it is too hard. The two hundred axes, being tempered together, are necessarily alike, and the trial of one or two proves them. If the edge bends too much, the



THE TEMPERING-FURNACE.

whole lot goes back to the heating-furnace and the bath, and then to the drawing-furnace once more ; if it breaks too quickly, the whole go into the drawing-furnace for another trial. It is rare, however, that any second attempt is necessary.

As the axes must be introduced and withdrawn through a small opening in the oven, it would seem that the time thus occupied would operate to keep some longer in than others, and thus make a difference in the tempering ; but trial has shown that so wonderfully sensitive are the axes to heat, that, if one hundred and ninety-nine axes are in the oven and partially heated, and the two

hundredth one be introduced cold, all those already in will not receive an atom of additional heat until the new comer is hospitably warmed into perfect equilibrium with the rest.

When tempered, the axe passes through the process of grinding, polishing, inspecting, covering the poll with asphaltum, and is then ready for packing. The polishing answers three important purposes, besides that of handsome appearance: it makes the axe enter the wood more easily, preserves it from rust, and exposes the slightest flaw to the keen eye of the inspector. So exquisite is this polish that it has sometimes been actually mistaken for silver plating.

This is a hasty sketch of the process of making the common "Yankee" axe. Many other varieties are made by the Collins Company — axes for turpentine-making, for miners, axes with double bitts, broadaxes, axes for South America and the West Indies, adzes, and hatchets; besides many forms of machetes, cane-knives, cleavers, hoes, picks, sledges, etc. The modes of making all these differ somewhat in detail from that described already. For instance, Brazil axes do not have the holes punched, but are welded, as the Brazilians like to insert a rough round stick for a handle; machetes, of which there are scores of varieties, are fitted with handles of wood, horn, and other materials, and are carried by every planter in certain southern latitudes.

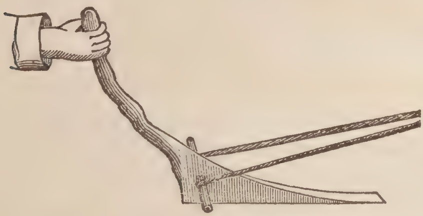


Fig. 1. ANCIENT PLOW.

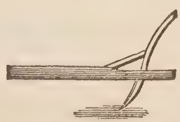


Fig. 2. PALESTINE PLOW.

A very important part of the business of Collins & Company is the manufacture of steel plows. The history of the plow, meagre though it is, from the first simple bent stick used to dig up the earth, to the perfect machine manufactured by Collins & Company, known as the "Eclipse Gang Plow," is not a little interesting.

It is impossible to say who was the first inventor of the plow.

The earliest records speak of it as a well-known instrument of husbandry, and we are therefore left to conjecture alone as to its origin. The first plow of which we have any delineation is figured roughly on the monuments of Egypt. This is believed to represent the original of all plows. It was sometimes formed of the limb of a tree, and sometimes of the body and tough root of a sapling, the lower end being hewed to a wedge. The plowman occasionally worked the implement by himself, applying his foot to the projecting pin, like a spade, but was oftener assisted by a team composed of a grown daughter and her mother attached to the plow by rawhide or hempen thongs. This same contrivance is *at the present day* used for a plow in the Hebrides. The plow still in use in Palestine is made entirely of three sticks, adjusted to support each other, as shown in the illustration. This is commonly drawn by a cow or an ass, and sometimes by camels. Figures 3 and 4 exhibit the plows of China and the East Indies. These countries do not seem ever to have changed or improved their plows in any important respect.

We present (in figure 5), page 118, an engraving of a Norman plow and plowman, from a sketch found in an ancient British manuscript. The plowman carries a hatchet to break the clods of earth, and the very faulty perspective shows it to be about the size of his team. The plow of the ancient Britons was very rude, no man being regarded as qualified to be a farmer until he could make his own plows. The custom was to fasten the plow to the *tails* of oxen or horses, and compel the poor beasts to thus drag it through the ground. An act of the Irish legislature was passed in 1634, entitled "An act against plowing by the taile," which forbade the cruel custom; but it was still practised in some parts of the island as late as the present century. The draught-pole was lashed to the tail of the animal, and, as no harness was employed, two men were necessary, one to guide and press upon the plow, the other to direct the animal, which he did by walking backwards in front of the miserable creature, beating him on the head on either side, according to the direction required. The beginning of the last century was signalized by a revival of interest in agriculture in England, and attention was more strongly turned to the improvement of

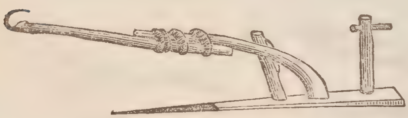


Fig. 3. CHINESE PLOW.

plows than ever before. A plow introduced from Holland, and known as the "Rotherham Plow" (perhaps the name was a corruption of Rotterdam), was first constructed and patented by Joseph Foljambe, of Yorkshire, which he soon after sold to a Mr. Staniforth, who, however, did not manufacture them himself, but charged a royalty of two shillings and sixpence on those made by others; but when he attempted to raise the price to seven shillings and sixpence, the validity of his patent was contested, and set aside by the courts, on the grounds that it was not a new invention. Ten years after the letters patent were granted to Foljambe for the "Rotherham Plow," Jethro Tull, an enterprising Englishman, published a work on "Horse Hoeing Husbandry," in which he advocated deep tillage, and the use of *four* coultered plows (similar to the ordinary knife coulter), but so arranged as to cut the furrow into four parts. Tull claimed great advantages for his four-coultered plow, but they were never very generally adopted; and as the same objects have since been accomplished in a more simple manner, it has fallen into disuse. James Small, of Scotland, was the next great improver of the theory and practice of plow-making. He established his manufactory at Black Adder Mount, in Berwickshire, in 1763, and died about thirty years after, signalizing every one of those thirty years by some new improvement of the various parts of his plow. He took the Rotherham plow as a basis, and improved it in nearly every particular. Indeed, he left the implement at his death so nearly perfect, that to this day it is used in many of the largest and best cultivated districts of Scotland, and is prized more highly than any other, being known as the *East Lothian Plow.* In 1785 Mr. Robert Ransom, of Ipswich, England, obtained a patent for making plowshares of cast-iron, and in 1803 improved his article by a mode of chilling or case-hardening them, for which he received a patent.

Fig. 4. EAST INDIAN PLOW.

One of the first to improve the plow in this country was Thomas Jefferson, the third President of the United States, who, in a communication to the French Institute, attempted to solve the mathematical problem of the true surface of the mould-board, and to lay down

intelligible and practical rules for its formation, for the first time. In 1793 Mr. Jefferson put his theory to the test of practical experiment, and had several plows made after his patterns, and put them into use on his estates in Albemarle and Bedford Counties, Virginia, and became fully satisfied of their practical utility. The first American, after Mr. Jefferson, who set himself to work to improve the plows in common use, was a farmer by the name of Charles Newbold, of New Jersey, who invented the first cast-iron plow ever made in America, and whose letters patent were signed by John Adams, President of the United States, in June, 1797. Mr. Newbold spent upwards of thirty thousand dollars in perfecting and introducing his plow, and then abandoned the business in despair, as the farmers had in some way imbibed the strange idea that the cast-iron plow *poisoned* the land, injured its fertility, and promoted the GROWTH OF ROCKS. The next plow patented was invented by John Denver, of Maryland, in June, 1804. There is, however, no definite record as to its peculiarities, which is also true of a plow patented February 24, 1804, by Hezekiah Harris, of Kentucky. A patent was granted to David Peacock, of New Jersey, April 1, 1807, which, no doubt, resembled Newbold's plow, as Newbold sued him for an infringement of his patent, and the case was settled by the payment of fifteen hundred dollars to Newbold. Peacock obtained another patent in 1822, consisting of some improvements in the various parts, but the chief feature was the famous lock coulter, which, it is believed, he was the first to introduce.

We have not space to name the various patentees of plows in this country on from 1812 to 1820, an interesting period in the history of plow improvements; but we note Mr. Jethro Wood, of New York, to whom letters patent were granted July 1, 1814, and again September 1, 1819. Mr. Wood's plow became exceedingly popular, and did more to drive out the clumsy plows of the olden time than any other which had then been invented. There were sold, in New York city, of Wood's plows, in 1817, fifteen

Fig. 5. NORMAN PLOW.

hundred and fifty; in 1818, sixteen hundred; in 1819, thirty-six hundred; and in the year 1820, the sales were largely augumented. It is alleged that Mr. Wood not only made no profits by his efforts to improve the plow, but that he actually lost large sums by his enterprise. Mr. Wood's efforts were, however, lately recognized by the New York State legislature, who appropriated two thousand dollars to his heirs. Many other plows were patented subsequently, but as they founded their claims to public favor upon some real or fancied improvements, and soon went out of use, it is unnecessary to describe them.

In 1836 or 1837, Daniel Webster, the great statesman, invented a plow for work twelve and fourteen inches deep, cutting a furrow twenty-four inches wide, which is still in existence, the property of his friend Peter Harvey. This plow is twelve feet long; the land-side four feet long. The mould-board is of *wood*, plated with thin iron straps, in the usual way of strapping wooden mould-boards in those days, and the beam was some twenty-eight inches from the ground. Mr. Webster designed this plow for a field on his farm at Marshfield, which was full of very strong roots, and it was accordingly made of great strength. Mr. Webster himself, with some six or eight assistants, held this plow, and expressed himself substantially as follows in regard to his monster plow:—

"When I have hold of the handles of my big plow in such a field, with four pair of cattle to pull it through, and hear the roots crack, and see the stumps all go under the furrow out of sight, and observe the clean, mellowed surface of the plowed land, I feel more enthusiasm over my achievement than comes from my encounters in public life at Washington."

To the various forms and sizes of wood and cast-iron plows heretofore mentioned, succeeded that important change in the *material* used for plows, viz., the substitution of sheet-steel for cast-iron. This was a great improvement in certain respects, as it enabled the manufacturers to greatly reduce the weight of the plows, without impairing the strength, and consequently lessened the draught of the plow; but experience has demonstrated, however, that in soils sticky in their nature, there is generally present a proportion of sharp grit, which soon cuts through the thin sheets, rendering the use of this class of steel plows quite expensive to farmers. The so-called "Smith plows," which are manufactured so extensively by Collins & Company, are an improvement upon the sheet steel plow.

"Plow-points," or shares, of cast-iron, rough as they came from the mould, and remaining rough until worn smooth by use, were in general use until a comparatively few years back, yet very unlike the light and elegant steel ones now manufactured by this company, and fast coming into use. The distinguishing peculiarity of the Smith plow, as made by them, is, that it is *cast* cast-steel; and this name is not a mere repetition of the word "cast" for the sake of sound, like "double extra superfine," but is a simple and literal title; the "cast-steel" expressing the material of which the plow is made, and the "cast" the mannner of making it. That is, the steel itself is first made, broken up, and then re-cast into plows. Cast-steel plows were made before the com-

ECLIPSE GANG PLOW.

mencement of this manufacture, and are made yet; but they are made of "sheet" steel, being *rolled* into shape. Their manufacture presents two difficulties: by being rolled, the thickness of the parts must necessarily be uniform, and after being rolled, it is impossible to temper them properly, without warping them out of shape. They must, therefore, be left untempered and soft, and in the gritty soil of the west, sheet-steel plows have been repeatedly cut entirely through by plowing no more than twenty acres. In 1860, however, Mr. F. F. Smith, who had been hammering away at sheet-steel plows in a prairie town in Illinois, had his attention attracted by the successful casting of steel bells in England, and he at once asked himself whether plows also could

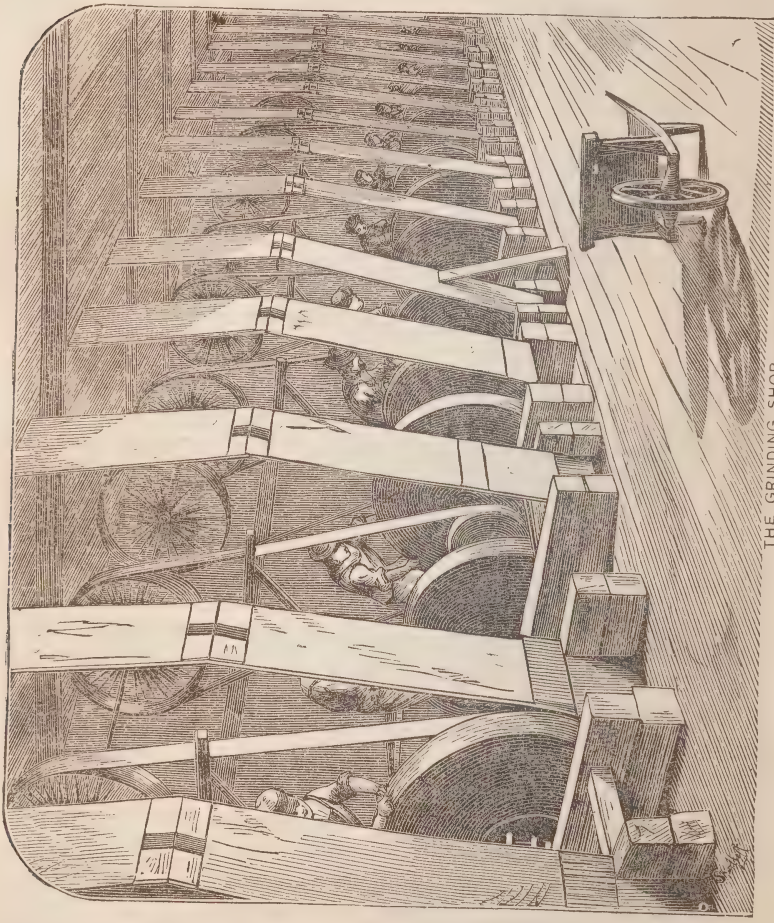
not be cast. Entering into correspondence with Collins & Company, he removed to Collinsville, and fell to work with the savage ardor of a man who feels that he has staked himself upon the result of his labor. Like most American inventors, he was full of one idea; he had lived for plows, and believed that the earth was created for nothing but to be plowed. There was no difficulty at all in making cast-iron moulds, or in pouring the steel into them; the difficulty was to cool the thin castings without cracking, and after a year's hard labor, even the superintendent of the works pronounced the plow a failure. But Mr. Smith did not think so; he had faith in his plow, and success has justified his faith, for more than one hundred thousand of these plows are now in use.

The three working parts, share, mould-board, and land-side, entirely of cast-steel, are taken from the moulds; the edges are then trimmed off; the hammering and tempering process are similar to those employed in axe-making; the parts are drilled, bolted firmly together, ground, and polished on emery-wheels. The share is *solid* for three inches back of the point; the land-side is an inch thick at the heel, and the mould-board is half an inch thick at the point where it presses the surface of the ground. The lightness of these plows is remarkable; an average English plow, made of wrought-iron, handles and all, and weighing two hundred and fifty pounds, large and clumsy in every part, can cut no deeper or wider furrow than a small plow of this pattern, weighing but forty pounds.

The process of casting secures three advantages. The wearing parts may have, and do have, a thickness varying according to the wear imposed upon them; the parts are all exact duplicates of one another, and if any part gives way or wears out anywhere in the civilized world, the owner can always procure a duplicate section from the nearest dealer, and can fit it into its place with the aid of a hammer and wrench. Moreover, the casting allows the parts to be tempered at will without destroying their shape, and it is mainly in its extraordinary hardness that the peculiar value of the plow consists. The invariable test of the temper of every plow is the broken end of a file, which must not affect the steel in the least. The point of a penknife of Sheffield make, pressed against it, slides along as it would slide on glass; breaking a file, we rub the jagged end upon the steel with all our strength, but no mark is visible. The natural result of this extreme hardness and polish is, that in any soil which can be found, the plow

"scours," or cleans itself, letting nothing scratch it or stick to it, thus reducing friction and draught to the minimum.

Revolving-coulters, as well as the old-fashioned knife-coulters, are made ; the circular cutter runs lightly over the ground, parting the grass and sharply cutting the sod just in advance of the share.



THE GRINDING SHOP.

This cutter, really beautiful in shape and finish, is like a circular saw deprived of its teeth, and gently carried down to an edge ; take it up and tap it gently with the finger, and it proves itself steel by ringing clearly, like a bell, for half a minute. The manufacture of "left-hand" plows, turning the furrow over to the left, is

also carried on; this style is bought chiefly by Pennsylvanians and Pennsylvanian emigrants, who have a habit of guiding their teams by attaching the rein to the left shoulder, and think they can "haw" round more easily than they can "gee" round. There is no reality in this notion; but just as the Spanish use an axe with a very broad bitt, because their ancestors happened to do so, the notion must be humored, and hence broad-bitted axes and left-hand plows are made.

The success of Collins & Company has been attained by a union of the three things which generally have been the causes of success in all successful manufactures, namely, first, manufacturing upon a large scale; second, minute division of labor; third, a most persistent and rigid system of inspection. In every process of the manufacture, operations are performed upon a large scale; twenty tons of steel are made at a time; hundreds of axes, and thousands of machetes, go through the processes all together, from first to last. The efficiency of this doing upon a large scale is especially marked in the all-important process of tempering, in which the slightest failure would be the ruin of all the work, however excellent that may have been. But no room for chances or variations has been left; a uniform process of heating has swept them away, and has supplied a certainty instead. By the old process of heating and tempering one axe at a time, there were as many chances for variations of temper as there were axes; but now two hundred are tempered together, and if one is perfect all must be. The division of labor also tends to bring certainty into the work. Each workman, whether he tends a furnace, or moulds, or hammers, or tempers, or grinds, or packs, or inspects, or whatever he does, does nothing else, so that his eye and hand acquire a certainty like that of a machine.

Then there is the inspection. There is a little army of inspectors, and the metal never escapes their eyes and their searching tests, from the time it enters the furnace to be converted into steel, until it has been wrapped in paper and boxed for shipment. After *each stage* in the manufacture comes the prying inspector, looking for faults, and the material cannot go on towards completion until it has received his private mark. Any defect sends it back to the department where the fault occurred, and to the particular workman through whose carelessness it occurred; no fault being seen, the material passes to the next stage, and when completed, receives a final inspection, every tool by itself. Then, and

not till then, the stamp, "Collins & Co., Hartford," is struck upon the metal, committing the company to the excellence of the work; and not until then are the painting, labelling, and packing begun.

Inspecting implies a care for reputation. The Collins Company have never tried to make low-priced tools; they have sought first to make perfect work, and then to sell it as low as it could be afforded. They have always been aware that, while to polish up and sell soft iron or brittle steel is an easy matter, it is not easy to sell it more than once to the same person; out on the western prairie, or in the forest somewhere, the bad plow or axe will give way under trial, convicting its dishonest maker, and making the purchaser remember not to buy *that* manufacture again. They intend to sell many times to the same person, and so do not allow their reputation to be endangered by any inferior work. Reputation is capital, and to keep reputation there must never be even a single instance of the sale of poor work — a fact of which all our American manufacturers are eminent exemplars.

The Collins Company are the manufacturers, and the works are located at Collinsville, in Hartford County, Connecticut, but the original trade-mark of "Collins & Co., Hartford," is retained. And how much is this trade-mark worth? It would be hard to say without seeming extravagant. Suppose another company, which should, if it were possible, make *better* tools than these, — or suppose that these very tools, now made and sold with this trade-mark, should be made by these men without it, — it is safe to say that in either case, forty years, at least, of hard work would be required to build up a business of equal extent with the present one. Yet what is the trade-mark, after all? There is no efficacy about it; it merely signifies that the name "Collins & Co." stamped upon a tool renders any asking of questions unnecessary; buy it at once, and trust it with safety. In the interior of the Gulf States it is hardly possible now to find axes which do not bear this stamp. In the West Indies and in South America it is almost impossible to sell an axe or a machete bearing any other; those tropical people are suspicious of Americans, but think themselves quite safe when they see the familiar stamp. Other dealers have found this out, and have acted upon it; so the printed labels read, "Look for the stamp 'Hartford' if you want the genuine Collins & Co."

The most remarkable fact is that even the counting-rooms of England have found out the value of this trade-mark by trying

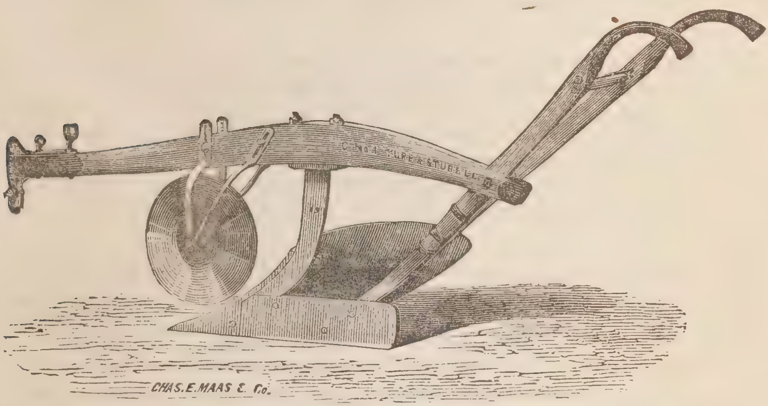
to compete with it; and they did not disdain to use it in their workshops, bearing unintentional tribute to the superiority of New England work. So long ago as 1858, certain Birmingham manufacturers having gotten into the habit of using the Collins trade-mark, a test case was made by the company, and a resort was had to the court for an injunction. This case, Collins *vs.* Reeves, was reported in full in the London Times, in July, 1858, and the New York Tribune at the time contained an editorial upon it. Vice-Chancellor Stuart granted the injunction, almost unwillingly, some might think, for he remarked that Mr. Reeves, whose line of defence was, that he was merely following the custom of the trade, had acted in a highly honorable manner throughout. What this highly honorable conduct was, it is not easy to see, unless it consisted in stopping a dishonest manufacture, and compounding in damages therefor, when compelled to do so. His defence was, that certain customers had directed him to affix the trade-mark, and that it was the custom of the trade to affix any trade-mark which might be asked for; furthermore, that he had reason to suppose that the Collins Company had granted the right to use this trade-mark to somebody else. This they had not done, and never could do, without endangering the reputation which has required forty years to acquire, and on the continuance of which their business depends; but if they had done so, — as the London Times remarks, — Mr. Reeves' plea is as absurd as if A had invited B and C to dinner, and the rest of the alphabet, hearing of the invitation, should all come at the appointed hour.

It is doubtful if any, even of successful American manufacturers, have a wider reputation and sale than those of the Collins Company. The remoteness of some of their customers is a little astonishing. Orders are received from Bohemia; and these plows are turning up the soil in Africa, New Zealand, and the "kindly" earth of Australia, which, as Douglas Jerrold so prettily said, is so kindly that if tickled with a hoe it laughs with a harvest. In every state in the west these plows push their sharp steel wedges into the soil. These picks ring in California. Not only do these axes chop and hew all over New England land, but they are in the pine forests of the Carolinas; they smell of fragrant woods in the tropics and in Brazil; they are poised on the hunter's shoulder, and swing in the miner's bag. And wherever, in the woods, or in carpenters' shops, or in the ship-yards, there is any hewing or any cutting of wood or of soil to be done, the stamp

"Collins & Co." is apt to be found on the tools which are doing it.

This manufacture is a triumph of skill, patience, and that fixed integrity in work which thinks somewhat of the work itself as well as of its pecuniary rewards, and is determined first to do the best work that can be done, and after that to care for the profits. Such ingenuity and integrity alone could suffice to establish a world-wide trade and reputation, the key to which is that, in the long run, that is sure to find recognition and general honor, which steadfastly refuses to follow the too common rule of putting the best on the outside, and being satisfied with what appears well enough to sell well. In a double way, a great manufacture like this is a benefit to the whole country. It has built up a thriving village, of which it is the main-spring, furnishing employment to nearly a thousand men directly, exclusive of those who are engaged in selling the manufactured products all over the world; and all these furnish employment in turn to others, whose industry is required to supply to them the necessaries of life. Iron and carbon, once lying inert in the soil, are converted, by receiving a certain expenditure of labor, into instruments for creating out of other inert materials a further large increase of material products which constitute wealth. As the steel punch produces a number of matrices, which each produces a large number of types, which each produces a yet larger number of electrotype plates, which each produces a yet larger number of printed impressions, so the production of tools and the increase of aggregate wealth grow by geometrical progression. The approach of the "good time coming" is an approach of the time when men shall be more worthy of leisure, and yet less fond of idleness; when they shall have freed themselves more than now from the rapacious demands which bodily necessities make upon their time; when they shall have more fully conquered nature into working for them, and thus leaving them more opportunity for self-culture. Nothing contributes more to this end than steel, and the better the steel the more effectual the contribution. The manufactures of "Collins & Company" are better helps to speed the millennium than a hundred prize essays could be; for they do not absorb wealth — they create it. They take it like seed, but return it a hundred-fold like harvest, and furnish the most practicable and most convincing answer to the question whether the vast stores of iron and coal in the United States were placed there for any purpose, and

whether these stores shall be utilized. The annual gain by the saving of labor in using the tools of Collins & Company rather than the inferior ones of foreign manufacture, aggregates thousands of dollars, and the foreign manufacturers themselves have unintentionally borne testimony to this when they fraudulently copied the trade-mark. Yet there are those who think it would be better to give up manufactures in which we have already beaten the shops of England, let our mineral wealth lie undisturbed, and buy all our manufactured products abroad. Such persons should



THE CAST CAST-STEEL COULTER PLOW.

consider Ireland and India. We may buy foreign products rather than make our own, but in so doing we shall inevitably paralyze our own arms, and set speedy bounds to our advance in prosperity. Agriculture and manufactures, inseparably connected, must flourish side by side, or the sure result will be disaster. With all the benefits accruing from the great industry which this article is written to illustrate, certainly not the smallest is, that it so forcibly and practically argues in behalf of supporting home industry, and relying upon American manufactures.

MANUFACTURE OF SALT.

THE FIRST SALT WORKS IN AMERICA. — SENDING SALT FROM VIRGINIA TO MASSACHUSETTS. — SOLAR SALT-MAKING DURING THE REVOLUTION. — WORKS ALONG THE ATLANTIC COAST. — DISCOVERIES IN DIFFERENT STATES AND TERRITORIES. — DEPOSITS OF ROCK SALT. — PRINCIPAL SALT-PRODUCING STATES. — THE SPRINGS AND WORKS AT SYRACUSE. — PROCESSES OF MANUFACTURE. — SOLAR EVAPORATION. — BOILING AND REFINING. — AMOUNT AND COST OF PRODUCTION.

SALT production is a most important industry in the United States. As a "manufacture" it is the earliest in American history, for the colonists at Jamestown, Va., established salt works at Cape Charles before 1620, and in 1633 began to send salt to the Puritan settlers in Massachusetts. In 1689 salt was made in South Carolina, and from the earliest settlement of the country it has been produced from sea water, by boiling or by natural evaporation, in large quantities, all along the Atlantic coast, especially during the revolution and the war of 1812, when foreign importations were difficult. The leading manufactories of this class were in Virginia, Delaware, New Jersey, Massachusetts, and Maine. After the revolution salt-making by solar evaporation became a very important business on Cape Cod; but the cheapness of imported salt, such as Turk's Island, — which means salt from any and all of the West India islands, — and the manufacture of salt from springs in other states, have made these works less profitable, though the manufacture of sea salt is still carried on to some extent on the New England coast, and largely of late in Florida, especially at Key West.

But away from the Atlantic coast, and outside of New England, no country in the world is richer in salt springs and deposits than the United States. Nearly every state and territory is, or might be, a large producer. Rock salt — especially valuable, on account

of the slowness with which it dissolves, in topping or "capping" meats cured with other salt — is found in Western Virginia, and a very important discovery was made in Louisiana in 1863. The salt "licks" and springs are found in no less than thirty of the states and territories. The springs of Southern Illinois were worked by the French and Indians in 1720. The Kentucky salt springs were known and used before 1790. The first salt manufacture in Ohio was in 1798. In Western Pennsylvania the business began in 1812. The important deposits in Western Virginia were early worked, and that state is now second only to New York in production. Later and valuable discoveries have resulted in the establishment of salt works in Missouri, Michigan, Nebraska, Texas, New Mexico, California, and Arkansas. California and Utah abound in salt lakes, especially Utah, with its "Great Salt Lake," which is, in fact, a Mediterranean, fifty miles in length by twenty in width, whose waters contain more than twenty per cent. of salt. The more important sources of supply, however, are, in the order of their production, New York, West Virginia, and Ohio.

Of these, New York produces more than one half of the entire domestic supply. A considerable portion of the north-western part of the state has abundant springs; but the principal springs are in Onondaga County, and the leading works are at Syracuse. The "Onondaga Salt Springs" were known to the French Jesuits who were missionaries to the Indians, and the white settlers began the business of manufacturing salt as early as 1788, producing, by boiling, in that year perhaps five hundred bushels, and from that time till now the business has grown from year to year to its present enormous dimensions.

The process of making salt at Syracuse — and it is nearly the same at all other salt springs in the country — is as follows: The springs are in the low marsh lands, in which wells to the depth of from two hundred to three hundred feet are sunk, and from these the salt water is pumped to the reservoirs which supply the evaporating works. The brine, which contains from seventeen to twenty per cent. of salt, is permitted to remain in the reservoirs till its impurities settle, and the deposit of these impurities is assisted by the addition of a minute portion of alum. There are two processes of making the salt — by solar evaporation and by boiling. Solar evaporation results in a coarser salt, used for curing meats, etc., and is effected by putting the water into large tanks six inches in depth, and exposing them to the sun and air. These

tanks cover hundreds of acres of ground at Syracuse, and the product of each tank (about 16×18 feet in size) is estimated at fifty bushels a year. The kettles for boiling hold about one hundred gallons of brine, and are set in parallel rows in brick "blocks" running the entire length of the different works. In boiling, the sulphate of lime and oxide of iron are removed or precipitated; the chlorides of magnesium and calcium are, by other processes, separated; the salt is thoroughly drained before it is barrelled; and thus is produced at Syracuse a pure, fine, white, and dry salt, which will not attract moisture in any climate or weather. How much the salt loses by this refining process is seen in the weight per bushel, which, for solar evaporated salt, is seventy pounds, while for the boiled salt it is a little less than fifty-six pounds. Every bushel of either kind pays a royalty of one cent to the state which owns the salines. The number of kettles now set at Syracuse are capable of producing from twelve to fifteen millions of bushels per year, and the actual production of the works is from eight to ten million bushels a year. About one eighth of the salt is made by solar evaporation, and the rest by boiling. In boiling, it requires a cord of wood or a ton of coal to make forty-five bushels, and the cost of manufacture depends upon the varying prices of fuel and labor; within ten years the actual cost of manufacture has been as low as one dollar per barrel of five bushels. The Syracuse salt has a high reputation throughout the United States, and it is to some extent exported, especially to the Canadas. The United States, however, can scarcely hope to compete in exportation with the cheaper foreign, particularly English, salines.

COINAGE, OR MANUFACTURE OF MONEY.

ANTIQUITY OF GOLD AND SILVER MONEY. — THE EARLIEST GREEK AND ROMAN COINS. — HOW MONEY IS MADE. — THE UNITED STATES MINT. — GOLD COINAGE. — INGOTS. — THE ROLLING ROOM. — THE DRAWING MACHINE. — FILLETS. — PLANCHETS. — MILLING THE EDGE. — ANNEALING THE BLANKS. — CUTTING THE DIES. — THE TRANSFER OR REDUCING LATHE. — THE PRESS. — NUMBER OF BLANKS STAMPED IN A MINUTE. — FINAL PROCESS. — BAGGING THE GOLD. — ESTABLISHMENT OF THE MINT AT PHILADELPHIA. — ITS IMPROVEMENT AND CAPACITY. — PIECES AND VALUES IN A SINGLE YEAR. — COIN WITHDRAWN FROM CIRCULATION. — USE OF COIN IN MANUFACTURES AND THE ARTS. — CURIOSITIES.

Gold and silver were used as "money," and as the best medium of exchange for values, in the remotest periods of antiquity. The "pieces of silver," however, mentioned in the earlier books of the Bible, were rings of metal, though stamped coins of a very early era are now extant. According to Herodotus, the Lydians were the first to stamp coins. The oldest Greek coins in the British Museum are those of Ægina, and they bear a figure of a tortoise on one side; and Phidon, of Argos, is said to have struck the first coins in Greece, 748 B. C. There is an abundance of Roman coins in various collections in Europe and America, bearing "the image and superscription" of Cæsar and other rulers, with medals commemorative of events and victories, to which we are indebted for the presumed portraits of great men of the different periods, and many of these coins show great artistic skill in the cutting of the dies.

In order to present a clear idea of how coins and medals are made or "minted" at the present day, it is only necessary to give briefly, and as perfectly as can be done without diagrams, a description of the processes pursued at the United States Mint at Philadelphia, which is believed to be behind no other mint in the world in the perfection of its machinery.

In converting gold, silver, and copper (or copper and nickel) into the coin of the country, the processes are so nearly similar that a detailed description of the manner of minting gold will be sufficient. The gold, alloyed to the proper standard for coin, comes to the mint in ingots, generally of about one hundred and eighty ounces, by far the largest part of it coming from the New York Assay Office. Ingots are sometimes, however, cast of different thicknesses and weights, according to the coin to be cut from them. The mint has its own assaying department, both for the reduction of such gold as it receives to "standard gold," as well as for testing the standard of the stamped ingots from New York and elsewhere. The standard in England is twenty-two parts of pure gold and two parts of pure copper, and in the United States, and most other nations, it is nine tenths pure gold and one tenth alloy. Whenever the assay of ingots, or other gold, is unsatisfactory, it is adjusted to the standard and re-melted.

The ingots are taken first to the rolling room, where they are heated to redness, and are then "broken down" between powerful rollers of chilled cast iron driven by steam. This operation is repeated five or six times, till, by adjustment of the rollers, the ingots are reduced to two tenths of an inch in thickness and five or six inches in width. The plates are then annealed at red heat for twenty minutes, and are plunged into cold water, which would make iron or steel hard and brittle, but it makes gold and silver tough and soft. After annealing, still further rolling is effected in different sets of rolls till the plate is of the required thickness; it is cut (or rolled) into "fillets" or strips which go next to the "drawing machine," which reduces the strip to a perfectly uniform thickness from end to end. Gold in passing through this machine must be lubricated with wax, though grease is used for silver, and after drawing, the strips are thoroughly cleaned with warm water.

The fillet is now cut into four pieces, and the "trier" cuts out one or more blanks from each strip, and weighs it in a delicate scale. If it is found that the strips are too thin, they must go back to the melting crucible; if they are too thick, they need further drawing; but so minutely can the drawing machine be adjusted, that there need not be the difference of half a grain in fifty blanks, and consequently in fifty coins. Satisfactorily tested, the fillets are next taken to the cutting-out room, where they are cut by machinery into round blanks or "planchets," a trifle larger than the intended coin. This is a rapid process, each machine cutting

blanks for two hundred and twenty double eagles, or two hundred and fifty smaller blanks, every minute. The perforated strips, or "scissel," are bundled up to be re-melted, and the blanks are sent to the adjusting room.

In this room every blank is carefully examined to see if it is perfect; it is minutely weighed, and if too light is laid aside to be re-melted, and if too heavy is "adjusted" by filing. The work is done by women, and this minuteness of weighing and examination is only with the gold pieces, and in gold a deviation of not more than three pennyweights in a thousand double eagles is permissible, which is the "remedy" for underweights and overweights, for the production of a large number of coins with the weight of each *exactly* equal is simply impossible. Of course the balances used, like every instrument and every machine used in the process of coinage, is of the utmost possible delicacy and accuracy of construction.

The next process is to raise the slight rim seen on the edge of the coin on either face, which protects the device and letters from wear. This is rapidly done in a "milling machine" at the rate of one hundred and twenty double eagle planchets a minute, and the edge is raised one thirty-second part of an inch.

During these preliminary processes the blanks have become so hard and so discolored that they must be annealed and cleaned before they are minted; if they were not annealed, the first blank in the press, instead of receiving the impression, might break the die. The blanks are accordingly arranged in "rouleaux" in iron or copper trays, the covers of which are sealed on with clay so as to make them as nearly air-tight as possible. These trays are subjected to a red heat for twenty minutes, are then taken out, and when cool are opened, and the blanks are thrown into cold water to anneal. When cold they are put into a bath of boiling sulphuric acid diluted with nine parts of water. In a few minutes the blanks are free from the oxide formed in the process of annealing, and are now perfectly "blanched." They are then washed to free them from every trace of the sulphuric acid, and are thoroughly dried by revolving them in a drum containing heated boxwood or basswood sawdust. From the drum they fall into a sieve, which rids them of the sawdust, and are then revolved for about an hour to polish each other by attrition. They are now ready for the most important and final process of coinage.

The dies from which the impressions on the coins are struck are

made as follows: The head, figure of Liberty or other device, is first made on a large scale, five or six times the size of the die for the coin, of wax, from which a brass cast is taken. This cast is the guide, from which a reduced copy (the cast is in relief) is cut into steel by an ingenious "transferring" or "reducing" lathe, one part of which carefully follows every part of the model, while a corresponding part cuts the reduced fac-simile in the steel. The machine thus reduces the cast in perfect proportion, leaving but little finishing to do by hand, and giving a "hub" or "male die" in relief, which, when hardened, is used to strike in soft steel, subsequently hardened, the reverse dies from which the coins are struck. The mint has at all times, for itself and for branch mints, complete sets of hubs and dies for all the denominations of coins. The transfer lathe is also used for the production of the medals ordered from time to time by Congress; and it may be mentioned here that transfer lathes on the same principle are largely used by engravers to produce on steel and copper plates medallions and other pictures, which, when printed, appear to be in relief.

There are several styles of presses for mints — Boulton's in the British mint, Thouvelier's French press, and Peale's and later improvements and inventions in use in the mint at Philadelphia. A diagram is necessary to give a complete idea of these beautiful and ingenious presses; but in general it may be stated that the coining press is almost a perfect automaton, which, when the blanks are fed to it through a tube, takes each blank in succession with a "hand" and lays it upon the face of the lower die. Both faces of the coin and the fluted or reeded edge (which is given to all gold and silver coins as a guard against filing) are struck with one blow, when the automaton hand displaces the coin and puts another blank in its place. The pressure for a double eagle is equal to seventy-five tons, and eighty can be coined in a minute.

Eight of these presses, driven by a steam engine, are in a single room at the mint, and are generally at work simultaneously, so that nearly twenty thousand pieces can be struck in an hour with only a girl or boy to attend each machine. The coins are examined at intervals during the minting process to see if there are any imperfections, and from the presses they go to the chief coiner's room, where the gold pieces are counted, weighed to verify the count, and are put up in bags of from one thousand dollars to five thousand dollars, according to the denomination.

This, in brief, is the complete process of coining gold, and the

processes for silver and copper are nearly the same. The double eagle weighs five hundred and sixteen grains, and lesser gold coins in proportion; a silver dollar weighs three hundred and eighty-four grains, — halves, quarters, dimes, and half dimes in proportion; the nickel cent — eighty-eight parts copper and twelve parts nickel — weighs seventy-two grains.

The United States Mint was established in 1793. It was quite imperfect till 1835, when Mr. Franklin Peale returned, after two years' examination of the mints of Europe, with all the latest inventions, which have since been immensely improved upon at Philadelphia. The capacity of the mint is shown in the fact that nearly seventy million pieces have been coined in a single year (1853); nearly fifty million dollars in value were produced in 1861; and in the first five months of 1861 the mint coined 12,248,037 pieces, worth $31,123,206. The almost total withdrawal of coin from circulation in 1862 materially lessened the necessary labors of the mint, though the presses have been constantly running to meet the demands of the government for its gold interest payments and for deposit; large amounts of double eagles especially are in daily demand for export and exchange purposes; and vast quantities of gold and silver coin, especially silver, are used in manufactures and the arts.

An interesting department of the Mint is the Curiosity Room, which contains specimen coins from nearly all the nations of the world. The European collections are very complete, and there are many coins from Turkey, Egypt, Tunis, Tripoli, Persia, the East Indies, Algiers, China, and Japan. The Mexican and South American series are very full. Some of the coins from the West Indies are extremely rare. This department also exhibits Greek coins of ages of from seven to three centuries B. C., and a superb collection of Roman coins dating from A. D. 395 to A. D. 1448. There is also a complete series of the coins of the United States dating from 1793, containing among other coins a cent which from its rarity is valued at one hundred and ten dollars. There are also specimens of African shell money. In this room there are samples of copper, silver, and gold ore from all the mines in the United States, and specimens of gold and silver from the most celebrated mines of other countries.

THE ICE TRADE.

AN AMERICAN ENTERPRISE. — ORIGIN AND GROWTH OF THE BUSINESS. — FREDERIC TUDOR, OF BOSTON. — THE FIRST EXPORTS FROM MASSACHUSETTS TO THE SOUTH. — THROWING A CARGO OVERBOARD. — ICE TO CALCUTTA, BRAZIL, AND ENGLAND. — AMERICAN ICE ABROAD. — MODERN IMPROVEMENTS IN ICE-HOUSES. — USES FOR SAWDUST. — SOURCES OF ICE SUPPLY. — QUANTITY REQUIRED FOR NEW YORK CITY. — SUPPLIES FOR THE WEST AND SOUTH. — VALUE OF ICE CROPS. — HOW THE CROP IS SECURED. — PROCESSES OF GROOVING, CUTTING, AND STORING. — MANUFACTURE OF ARTIFICIAL ICE.

Cutting and storing ice in large quantities for export and for domestic supply is a strictly American enterprise, which began nearly seventy years ago, and from a small beginning has grown to a great business, employing throughout the northern states thousands of men and millions of capital. Besides the great depots, like Portland, Maine, and Boston, where ice is stored for export, and the vast supplies now needed for large cities, almost every town has its local company or companies, to supply what has long since ceased to be a luxury, and has become a necessity in almost every family. The importance of this product to the meat-packers of the West, and to marketmen everywhere, alone would make the ice business prominent among the industries of the country.

The export of ice was first undertaken by Frederic Tudor, of Boston, who sent a small cargo to Martinique, in 1805. Ten years later be began to send ice to Cuba; in 1817 and 1818 to Charleston and Savannah; and two years later to New Orleans. The story is current that the first cargo to New Orleans, arriving in the height of the yellow fever season, so alarmed the Creole population, who were ignorant of the precise purpose and character of the shipment, that a riot ensued, during which the entire cargo was thrown overboard. Subsequent shipments, however, made known the value and importance of an article in a city where ice has since commanded in different seasons, according to the supply, from fifteen to one hundred dollars per ton.

The success of these shipments to the South induced Mr. Tudor, in 1833, to send a cargo to Calcutta, and the year following to Brazil. Other Bostonians and other New England seaports soon went into the trade, and ere long Kennebec River, Cambridge Fresh Pond, and Lake Wenham ice was known everywhere abroad, from London and Liverpool to Calcutta and Canton. Modern discoveries, too, have resulted in methods of laying in cargoes, and especially of building ice-houses in warm climates, so as to permit as little wastage by melting as possible. The business has also developed a use for the enormous quantities of sawdust made in the lumbering districts, and an article which was once suffered to run to waste is found to be the most valuable material for packing and storing ice in houses or on shipboard.

Outside of New England the sources of domestic supply are, for cities and towns in general in the interior, the nearest rivers, fresh ponds, and lakes; for New York city, which requires at least three hundred thousand tons a year, Rockland Lake, in Orange County, which can furnish more than one-third of the entire supply; the ponds and lakes near the Hudson; the Hudson River, at Athens, Hudson, and above; and in some seasons large quantities have been brought from Saratoga Lake, Lake George, and Lake Champlain. The great lakes are the main source of supply to the West and the Mississippi Valley, and supplies are sent down the river and by rail to all the southern cities. The value of the ice crop in good seasons throughout the North is enormous. Apart from the lakes and great ponds owned by companies, it is not infrequent that the uncut ice on ponds near a large city will be sold for more money in a single winter than the whole farm on which the pond is situated originally cost. This was particularly true of ponds in Poughkeepsie and elsewhere near the Hudson during the scarcity and high-price season of 1868–69.

The following is the method of securing and storing the ice crop: On the banks of the rivers, ponds, and lakes, at convenient distances, are built large ice-houses, constructed with double walls lined with tan, sawdust, hay, shavings, or other non-conducting substances, which will exclude heat and air as much as possible, and each capable of holding from twenty thousand to sixty thousand tons of ice. When ice has "made" of suitable thickness, say from nine to twelve inches, the snow is taken off with scrapers drawn by horses, and if there is a porous thaw or "rain-ice" surface, it is planed off by means of steel-blade scrapers. The next

process is grooving the ice with a machine similar to a harrow, the teeth of which mark out the surface in blocks of the size to be stored. A section of these blocks is sawed out, and then the whole surface is split off in sections with "ice spades." These sections are hauled or floated to the ice-houses, where they are broken into the blocks made by the grooves, are hoisted in, — by steam generally, — are compactly piled till the house is filled, and are then ready for delivery and shipment in the ensuing season. The gathering of the crop may go on by moonlight as well as by daylight during the short, sharp, and busy season, and the process on the largest scale can be seen to the best advantage at Athens, on the Hudson River, at Fresh Pond, Cambridge, or at Lake Wenham, Massachusetts.

Within a few years considerable enterprise and capital have been engaged in New Orleans and other southern cities in the manufacture of artificial ice. Several machines for this purpose have been invented in the United States, in England, and in France, and in recent experiments at the South the French machines have been preferred. The principle of all the machines is the same — to produce intense cold by rapid evaporation; and ice and salt, or nitrate of ammonia and water, or sulphuric acid, assisted by the air pump and the steam engine, are used in the process. By these machines pure ice is produced; but the machines are expensive, though it is claimed that ice by this process can be produced at the South in large quantities as cheaply as it can be imported from the North.

In one of the latest established artificial ice manufactories, at Atlanta, Georgia, the machinery employed weighs fifty tons; the agent for evaporation is *aqua ammonia*, which is deposited in an upright cylindrical evaporator, through which steam pipes pass, generating steam, which passes into a liquefier, where it is condensed, and goes by pipes through the freezing baths. The ammonia is returned to the evaporator, and is repeatedly re-used. The water in the cans comes out in clear, hard cakes of ice, weighing twenty-five pounds each, and four cans are emptied every five minutes. By carrying on the works night and day, this manufactory can turn out fourteen tons every twenty-four hours, and it is intended to produce at least ten tons of merchantable ice every day.

WATER WHEELS.

THE IDEA OF UTILIZING THE ENERGY OF RUNNING WATER. — THE CLASSIFICATION OF WATER WHEELS. — THE THEORY OF HYDRAULICS. — THE OVERSHOT WHEEL. — THE UNDERSHOT WHEEL. — THE BREAST WHEEL. — THE TIDE WHEEL. — TURBINE WHEELS. — THEIR INVENTION. — THEIR IMPROVEMENT. — EXPERIMENTAL TESTS. — THEIR INTRODUCTION INTO THE UNITED STATES. — IMPROVEMENTS SUGGESTED HERE. — THE ECLIPSE DOUBLE TURBINE. — ITS CLAIMS, AND HOW IT SUPPORTS THEM.

The idea of applying the energy of running water as a motive force for machinery must have early occurred to mankind, since all record of its first practical application is lost. At the present day many of the semi-civilized nations, who, in other respects, are quite backward in invention, have arrived at the use of water wheels in their rude industries.

With the study of hydraulics, the various applications of the energy of running water have been classified into two general divisions, according as the position of the axes of the wheels used are horizontal or vertical. The first of these is the kind of water wheel which was always used in early times, since it is the simplest in construction, and does not require an accurate or scientific knowledge of hydraulics.

In theory, the natural force of the current, the energy of the stream, should be equal to the volume of water which in a given time strikes the floats of the wheel multiplied by the amount of the fall, or the descent of the stream within a given space. In practice, however, the irregularities in the volume and in the velocity of the stream from time to time, and the loss from the friction of the stream against the sides and bottom of its bed, have shown that it is better to remedy these faults by gathering a body of water large enough to serve as a steady supply for some time, and then, through a properly constructed canal or channel,

draw the supply needed for imparting the required force to the wheel.

This result is obtained by building a dam, or weir, across the stream, and throwing the water back into a pond; thus obtaining a supply, or head of water, which may be drawn from at pleasure. From this reservoir a canal, opening with a flood gate, supplies the water for the wheel, at any desired elevation, or in any desired quantity. In theory, from a pond of water filled to a certain depth, a stream of water of the same volume will exert the same energy, whether it be drawn from the top and allowed to flow over the wheel, or be drawn from the bottom and directed against the wheel, or whether it be drawn midway, and flow against the wheel in its course to reach the same level, which it attains in each of these three cases. This conclusion is derived from the knowledge of the equal pressure of water in all directions, and since the force imparted to the stream from the top, by gravity, is equal to that imparted to the stream from the bottom, by the pressure of the superincumbent water in the pond. In practice, however, this theoretical conclusion is found to be modified by the resistance of the air, the friction of the sides, the eddies, and other causes.

Water wheels whose axes are horizontal are therefore divided into four classes, according to the manner in which the energy of the stream is directed against them. These classes are overshot, undershot, breast wheels, and suspended or tide wheels. In the overshot wheel the top of the wheel is placed at the level, or a little below the level, of the water in the reservoir, and the flow of the water is regulated by a flood gate. The stream of water is received in chambers, formed of planks, extending between the two sides of the wheel, and placed at an angle, or curved towards the stream. These planks are called buckets, and the wheels so constructed are sometimes called bucket wheels. It has been proved by experiment that the greatest effect is produced when the diameter of the wheel equals the fall of the water; but, as a general rule, other things being equal, the slower the revolution the more effectually is the energy of the water utilized; since, in this case, the water is not thrown off by the centrifugal force of the wheel, but, having time enough, can enter the buckets more evenly and regularly, and has its energy more completely exhausted, before the revolution of the wheel allows it to escape and flow away. The velocity allowed the water is generally from

three to five feet a second, the motion imparted by the revolution of the wheel being increased in the machinery by well-known mechanical devices. Wheels of this kind are suitable for falls of from ten to fifty feet high. The buckets are not increased proportionately to the increased diameter of the wheel ; about twenty-four buckets being provided for a ten-foot wheel, while one of twenty feet has fifty-six, and one of forty feet one hundred and eight. Under the best conditions a wheel constructed in this manner utilizes about seventy-five per cent. of the energy of the stream.

An undershot wheel is placed either directly in a running stream, or close to a fall or a dam. In this last case the water is drawn from the reservoir by a flood gate made at the bottom of the dam, and issuing with force, acts against the floats or palettes with which the wheel is provided, thus forcing it to revolve. By experiment it has been found that the thickness of the sheet of water allowed to flow through the flood gate should not exceed .82 of a foot, nor be less than .492 of a foot, while the floats should be a little more than two feet in width. The diameter of the wheel should be between thirteen and twenty-six feet, and the floats should be placed at distances about equalling their width. If the wheel moves with the velocity of the stream, being merely carried by it, it would not transmit any of the energy of the current, since the floats would offer no resistance to the current. On the other hand, if the resistance of the work to be done was so great as to hold the wheel stationary against the force of the stream, the wheel would not move, and there would be no motion. The point at which the greatest amount of the energy of the stream would be utilized must, therefore, lie somewhere between these two points of the maximum of motion with no power, and the maximum of power with no motion. By experiment it is found that the point at which the maximum of energy is utilized, is when the velocity of the wheel is forty-five per cent., or nearly one half, of the velocity of the stream. In consequence, however, of the friction of the water, the irregularity of the stream, and the impossibility of utilizing, by the agency of the floats, all the energy of the current, the average amount of the energy made use of is low in undershot wheels, amounting, as an average, to between twenty-five and thirty-three per cent. of that furnished by the stream. Therefore undershot wheels are less frequently used.

An improvement in their construction, however, is made, in which the floats are curved, so that the water rises in them more uniformly, and, being retained longer, more of its energy is utilized. In this improved form, which is known, from the name of the inventor, as Poncelet's wheel, the floats are nearly double in number, compared with the usual form, and the percentage of the energy of the stream which is utilized is raised to between fifty and sixty.

The breast wheel resembles the undershot wheel in its construction, but has its floats placed nearer together, and inclined somewhat towards the stream. It is so set, with reference to the stream, that about one-quarter of its circumference turns close to a channel corresponding to the curve of its circumference, down which the water, supplied through a flood gate, descends. The object of this arrangement is to make use both of the weight and the momentum of the water, and, as in this respect the breast wheel holds an intermediate position between the undershot and the overshot wheels, it stands also in the same position with regard to its value. Being less loaded with water than the overshot wheel, it works with less strain or friction upon the bearings, and, under the most favorable conditions, utilizes about sixty-five per cent. of the energy of the stream. From experiments it has been decided that the diameter of a breast wheel should not be less than sixteen feet nor more than twenty-three, while the best results are obtained from falls which are not less than four nor more than ten feet high. According as the stream is received against the wheel, above or below its horizontal diameter, the wheels are called high or low breast wheels.

A suspended wheel is one intended to utilize the current of a river in which it is set. They are generally used for temporary puposes, and are frequently set like the paddle wheel of a steamboat, and sometimes in pairs, one on each side of a boat moored in the stream, the shaft being connected with the machinery on the shore. The power utilized by wheels of this description is found to reach its maximum when their motion is about forty per cent. of that of the current of the river. Their diameter should not exceed fifteen feet, their floats numbering from twelve to twenty-four. A wheel of this description which is moved by the tide is called a tide wheel, and is generally furnished with a mechanical arrangement to utilize both the ebb and flow of the tide,

by moving the machinery in the same direction, whichever that of the wheel itself may be.

The largest water wheel with a horizontal axle in the world is said to be an overshot wheel in the Isle of Man. It is used in the working of a lead and silver mine. Its diameter is seventy-two feet and a half, its breadth is six feet, and it has a stroke of ten feet. Its power is estimated as equal to two hundred horse power, and it pumps two hundred and fifty gallons of water to a height of four hundred feet every minute.

In modern times the attention of inventors has been turned to water wheels with vertical axes, and the greater advantages of these, in economy of construction and increase of power, has led to their very general substitution for the old-fashioned water wheels with horizontal axes. Wheels of this kind are generally called turbine wheels, from the similarity of their construction to the shells of this name, with spirally formed chambers arranged about a centre.

Turbine wheels are horizontally submerged in the water, and provided with curved vertical buckets, or floats, which revolve around a fixed horizontal disk provided with guides to direct the impelling stream of water, and are thus made to revolve, carrying a shaft or axis running through the centre common to the wheel and the disk. The earliest suggestion in modern times, which in a very general way suggested the idea of the turbine wheel, was the arrangement known as Barker's mill, which is now used more as a philosophical toy, or as a spout for small fountains, than for any more practical purpose. In this a hollow vertical shaft receives the stream, and discharges it from horizontal arms curved at the ends. The force of the water as it discharges presses upon these arms in the opposite direction, and causes them to revolve. Sometimes the same effect is produced by making the horizontal arms straight, and discharging the water through holes in their sides.

In France what is called the spoon wheel has been long in use. In this arrangement a vertical axle is provided with a number of curved blades, projecting from it horizontally. A descending stream of water is projected against these arms, and thus a fair percentage of the energy of the stream is utilized, when the supply and the fall are not too great.

The turbine wheel proper was, however, first brought into practical use, if it was not invented, by a French inventor, Benoit

Fourneyron, about 1834. In his machine there were two reservoirs of water, at different levels. In the lower of these the wheel and disk are submerged, and the water from the upper reservoir descends vertically through a hollow cylinder upon the disk, or fixed solid circular plate below. As the cylinder does not reach quite down to the disk, there is a lateral circular opening, of small size, completely around and between the two. This circular opening is enclosed with the horizontal wheel, which is thus annular in form, and turns round outside of the disk and cylinder. This wheel is formed of an upper and lower crown separated by a space of about a foot, and is horizontal in position and annular in form. In the space between the upper and lower crown are arranged vertical floats, or buckets, which are curved, resembling in this respect the floats of the Poncelet undershot wheel. The upright guides fixed upon the disk direct the issuing stream of water against the curved floats of the wheel; and, as the water issues upon all sides, it acts upon all the floats at the same time, and continually, thus forcing it to revolve, and with it the axis to which it is attached. The volume of water discharged into the apparatus is regulated by a movable hollow cylinder, called a regulating gate, and working along the fixed cylinder. The guides upon the fixed disk are curved similarly to the buckets, but in an opposite direction, so that the water escapes from them at a tangent, thus striking the buckets almost perpendicularly, and greatly increasing its action upon the wheel.

Some modifications have been made in the construction of this original form of the turbine wheel, one of which, by Fontaine, was exhibited in the London Exhibition of 1851; another modification is known as Jonval's; but the performance of these wheels, like that of Fourneyron's, is to secure the utilization of from seventy-five to eighty per cent. of the energy of the water—a result which is a great improvement upon that of the ordinary water wheels.

The chief advantages of the turbine wheels over all other forms for utilizing the energy of running water may be concisely stated thus: They occupy but little space; their action is uniform and steady; the wheel being submerged, there is no strain or increased friction upon the axis in any one direction; they turn with great velocity; being submerged, they are not affected by ice; they utilize a greater percentage of the energy; and their efficiency does not decrease in the same ratio as their velocity.

Until about 1843 the water wheels in use in the United States

WORKS OF THE STILWELL & BIERCE MANUFACTURING COMPANY, DAYTON, OHIO.

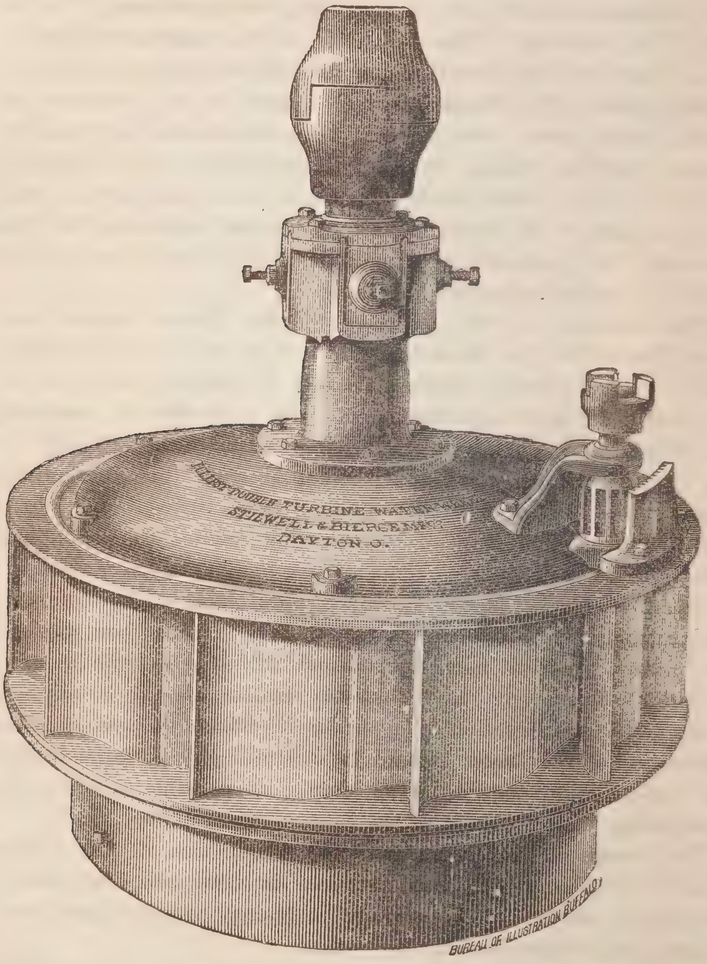
were always those with horizontal axes. In this year Mr. Edward Morris printed, in the *Journal of the Franklin Institute*, a translation of Morin's *Experiments on Turbines*, and gave, also, an account of some experiments made upon two turbines, which were constructed from designs of his own, and one of which utilized seventy-five per cent. of the energy of the stream. In 1844 Mr. U. A. Boyden, of Massachusetts, built a turbine for the use of a cotton mill in Lowell which utilized seventy-eight per cent. of the power. He afterwards built others, of one hundred and ninety horse power each, for the same manufacturing company. Besides this, Mr. Boyden, in his work published in 1855, at Boston, under the title *Lowell Hydraulic Experiments*, has given a valuable account of his experimental researches respecting the construction and proportions of turbines, and also many data of value on other hydraulic questions.

The attention of the industry of the United States being thus directed to the advantages of turbine wheels, the inventive talent of the country began naturally to interest itself in their improvement, and experiment in new methods for combining excellence and cheapness in their manufacture. Among the variety of turbines which have resulted from this competition, the Eclipse Double Turbine, made by the Stilwell and Bierce Manufacturing Company, of Dayton, Ohio, claims the first place. The turbines made by this company are built upon the model of a wheel invented by Mr. J. O. Joyce, after years of careful study and comparison of the merits and defects of those previously in use. As a practical mechanician, and with the experience of an inventor, Mr. Joyce saw that his efforts should be directed towards the construction of a turbine in which the reception and discharge of the water should be scientifically performed, while the construction should be as simple as possible, avoiding the complexity which is so injurious in mechanism of any kind.

The result of his labors was the production of the Eclipse Double Turbine, which was patented in 1868 and 1870, and for simplicity, durability, percentage of energy utilized, and price, challenges comparison with any other.

One of its peculiar merits is the conical interior of the wheel, by which ample vent is afforded for the free discharge of both tiers of buckets. This important improvement effectually prevents any reaction of the water, and forestalls any demand upon the wheel of the dead weight of water whose energy has been

consumed. Another point is having the water ways or chutes fixed, being cast with the wheel case in one piece, so that the water is delivered upon the wheel always at the same angle, whether the gates are fully or only partially opened. This



feature is peculiar to the Eclipse Turbine. A third point is the construction of the register case, by which the amount of water delivered to the wheel is regulated without ever changing the direction of the stream, or its relative angle with the face of the

bucket, or checking the velocity of the water admitted. This is a most important point for economy in the use of the water. Another point of importance is the simplicity in the construction of the machine; the wheel, wheel case, and register case being each cast in a single piece, and thus all the complication of the construction in parts being done away with; while, being manufactured to measurements, any portion which may need to be replaced can be readily obtained.

From the experimental tests of the effective power of the Eclipse, made with a dynamometer, the accuracy of which had been previously tested and found correct, it was found that the energy of the stream utilized amounted to eighty-seven and twenty-six one-hundredths per cent. This astonishing result was obtained from a wheel twenty inches in diameter, with a fall of fourteen feet ten inches, under several trials, repeated on different days during nearly three months, and is justly claimed as the best result ever obtained with an iron turbine. Nor was this a mere experimental test, made under fortuitously favorable conditions; but in other instances, the results having been equally favorable, the company insure a similar result from each wheel of their manufacture.

LITHOGRAPHY.

ITS ADVANTAGES. — THE INVENTOR. — ALOIS SENEFELDER, OF BAVARIA. — THE PROGRESS OF THE ART IN EUROPE. — ITS INTRODUCTION IN THE UNITED STATES. — THE FIRST AMERICAN SPECIMEN. — ESTABLISHMENTS IN BOSTON, NEW YORK, AND PHILADELPHIA. — REMBRANDT PEALE AS A LITHOGRAPHER. — THE STONE. — WHERE IT COMES FROM. — HOW DESIGNS ARE MADE. — THE PROCESS OF PRINTING. — ETCHING. — AUTOGRAPHY. — CHROMOLITHOGRAPHY. — PAINTINGS EXACTLY COPIED. — FRUIT, FISH, FLOWERS, AND GAME. — PHOTOLITHOGRAPHY. — APPLICATIONS OF THE ART. — LITHOTINT. — ZINCOGRAPHY. — NUMBER OF LITHOGRAPHIC IMPRESSIONS IN A DAY. — A NEW LITHOGRAPHIC PRESS. — LITHOGRAPHIC SIGN-GILDING. — SUPERIORITY OVER WORK DONE BY HAND. — CHEAPNESS OF THE PROCESS. — EXTENT OF THE BUSINESS. — LITHOGRAPHIC COMMERCIAL WORK.

Lithography is the art of drawing or engraving upon stone designs from which impressions can be taken on paper. It is a branch of engraving, and an important one, since it has to a great extent superseded engraving on steel and copper, particularly for maps, plans, and commercial purposes. Its comparative cheapness — the cost being only one-third that of engraving upon metal — commends it to general use; and with the advance in the art, designs are now produced which are very little inferior to the best specimens of wood and steel engraving of the same class. The art was the discovery of a Bavarian, — Alois Senefelder, — who, according to the well-known story, happened to make on stone a memorandum of his washing, when it occurred to him to attempt to take an impression on paper. He succeeded, and lithography, or the art of writing on stone, was invented. This was in 1795. A year afterwards Senefelder was printing music by the new process; he secured patents in the German states, and made important improvements. Rome and London introduced the new art in 1807, and Paris in 1814, and the simplicity and utility of the process soon made it popular throughout Europe.

The first specimen of lithography executed in the United States

was published in the *Analectic Magazine* for July, 1819. In the same year, discoveries of a white stone, suitable for the work, were made in Indiana. In 1822 Messrs. Barnett and Doolittle, who had learned the art in Paris, began the business in New York. In 1827 William S. Pendleton imported lithographers and materials from London, and opened an establishment in Boston. In the year following Philadelphia had two lithographic establishments, one of which employed Rembrandt Peale, the portrait painter, as draughtsman. Other lithographers followed in Boston, New York, Philadelphia, and other cities, and their principal business was the production of portraits, cheap pictures, — sometimes gaudily colored by hand, — and sheet music. The vast variety of uses to which lithography, in all its branches, is now applied, is the result of the progress made in the art within a few years.

The stone used is a light-colored yellow or blue-gray calcareous limestone, the best of which come from Bavaria, though they are found in France; and, quite lately, an excellent stone is brought from Cape Girardeau, in Missouri. The stones are sawn to a thickness of from one and one-half to three inches, are ground to a level face (in some establishments by machinery), and are polished by rubbing the faces of two stones together with fine sand and water. The stones are carefully selected with regard to the fineness of the proposed work, and the surfaces are smoothly polished or grained to the required degree — different surfaces being necessary for different classes of designs. When worn, or when the requisite number of impressions have been taken, the surface may be reground for another design.

The lithographic crayons with which designs are drawn, or which may be reduced to an ink and laid on with pens and brushes, are made of tallow, white wax, soap, shellac, lampblack, and turpentine. When the design is completed the stone goes to the printer, who dampens it with water mixed with a small quantity of nitrous acid. The pores of the stone take in the water, while the grease in the ink or crayon keeps the design dry; and when the roller, charged with ink, passes over the stone, the design readily absorbs the ink, and leaves the rest of the surface entirely clean. An impression may now be taken on moist or dry paper, and, with subsequent inking for each, any number of impressions, till the design is worn off.

This is the simplest process of lithography. By another method

the face of the stone is covered with a black or red-colored gum-water, through which the design is etched with the needle or diamond point (as in copper and steel plate engraving). The engraved white lines absorb the oil, which is then applied; the gum-water is washed off; and the design may be inked and printed as in the first process.

Autography is the process of transferring to stone writing or drawings made on a prepared transfer paper, which gives on stone a reverse, which may be printed from. This process is much used for circulars, price-currents, and commercial letters, which thus present the appearance of having been written. It also relieves the draughtsman from the tedious and difficult labor of writing a reverse on the stone. Fresh painted charts, maps, book plates, crests, arms, or other engravings in which the ink is yet wet, may be similarly transferred to stone. Autography has added an attractive feature to books by enabling the publisher to present facsimile pages of the author's manuscript, while, for commercial purposes, it is one of the most useful applications of the art.

Chromolithography, or printing in different colors, has been brought to great perfection in Germany, France, England, and the United States. By this process designs are printed in two or more colors, each stone carrying a different color, and being engraved or drawn with the design which is to be represented in a particular color. In printing from one stone after another, by which the successive shades and colors are transferred to the paper till the design is completed, the most accurate registration is imperative. For ordinary purposes, such as checks, drafts, business cards of all sizes, title-pages, etc., only two or three colors are used, though sometimes even this class of work is very elaborate in design and coloring. As applied to the copy of oil paintings, however, chromolithography may fairly claim place among the fine arts. The German chromolithographs, particularly those executed in Vienna, are considered the best; and then, in order, come those of Berlin, London, Paris, and the United States. By this process, copies of paintings have been made so accurately, with so perfect a reproduction of every shade of coloring, that the chromolithographic copy can scarcely be distinguished from the original painting. It is especially applicable to copies of fruit, fish, flowers, and game. Some of the pictures produced by this process in the United States (such as Tait's "Chickens") are wonderfully popular, and are unsurpassed by any chromolithographs of the same

class made in Europe. The process is also much used in landscapes, marine views, and portraits. Copies of old pictures, with the cracks in the paint, and other marks of time, have been reproduced in most faithful fac-simile. This beautiful art enables purchasers to procure, at a comparatively small cost, almost perfect copies of celebrated and costly pictures.

This is by far the nicest process in lithography, requiring, as it does, the greatest accuracy in registration. Exact copies of the outline of the design must be transferred to as many different stones as there are colors to be introduced, and these are charged in the proper parts with the primary tints, while one or two stones, from which the second and third impressions are taken, give the lights and shadows. Other stones are used to print in the shades which modify or blend the other tints; and, last of all in the process, a wash or glaze softens and subdues the colors, giving the picture its resemblance to the oil painting of which it is a copy. Proper care in *exact* registration prevents one tint from printing upon and blurring another, or from destroying the distinctness of the outline.

Photolithography is another most important branch of the art. Photographing upon wood only gives a design which must subsequently be cut as if it had been drawn in the usual way, but photographing upon stone leaves an impression which may be inked and printed from, as from the ordinary design. A method has been devised by which copies from plans or engravings may be obtained in an enlarged or reduced size, and the process of reduction is particularly valuable in obtaining copies of topographical maps, the original of which may be drawn on an enlarged scale, so as to include all the features and lettering, which will be accurately repeated on a smaller scale in the reduced design secured by photography. Wood-cuts and engravings are similarly enlarged or reduced in photolithography, and the discovery affords a new and economical method of illustrating books, and in supplying cheap copies of popular engravings. It has been used with great success, also, in reproducing the printed pages of books, thus giving fac-simile copies of old and rare works.

Some attempts have been made at what is called "lithotint," in which the design is painted with camel-hair pencils and a liquid preparation of lithographic chalk. Zinc plates are sometimes used instead of stones, in which case the process is "zincography." These plates present the advantage of cheapness, and designs can

easily be made on them. For some kinds of work they are well adapted, as the oily ink is readily imbibed, and the polished surface rejects water; they are chiefly used for architectural and machinery drawings.

On an ordinary hand-press a workman will print sixteen hundred lithographic impressions in a day. A lithographic printing-press has lately been invented, however, which is to lithography what the Gordon press is to letter-press printing. With this press, fifteen hundred impressions — or nearly a day's work on a hand-press — can be taken in an hour. It is especially adapted to bill-heads and other commercial work.

One of the recent and most ingenious applications of lithographic printing is seen in the metal signs which present the letters and designs in gold on a black ground, or in black on a gold ground. The design upon the stone is made with an albuminous mixture, and when the impression is printed on the metal, gold leaf is laid on, the superfluous gold is brushed off, and the letters and other parts of the design appear on the surface; the sheet is subsequently heated to harden and fix the impression. The metal is a fine and thin Russia sheet-iron rolled expressly for the purpose, and afterwards japanned with a highly glazed surface in this country. The most elaborate designs are thus transferred in gilt to these plates, with a minute finish and perfection of detail which no sign painter could attain, while the cost of such signs, as compared with those that are gilded by hand, is trifling. A sign for which a sign-painter would charge fifty dollars can be produced by the lithographic process for three dollars; but, of course, the lithographic process is only used when large numbers of the same sign are needed, as for insurance and other agencies, fire-alarms, etc., as the cost of a single lithographic sign would be more than that of one done by hand. This branch of the art has only lately been introduced into the United States, and the business is already enormous.

At present, the higher grades of lithography, chromolithography especially, are better done in Europe than in America; but in autography, and in all classes of commercial lithography, more and better work is done in this country, since here lithography has almost entirely superseded the copper and steel engraving, which is still employed to a great extent in checks, bill-heads, and other commercial work in Europe.

STEREOTYPING AND ELECTROTYPING.

STEREOTYPE PLATES. — THEIR ADVANTAGES. — SAVING WEAR OF TYPE. — JOHN MULLER OF LEYDEN. — VAN DER MEY. — WILLIAM GED, OF EDINBURGH. — THE DIDOTS, OF PARIS. — EARL STANHOPE'S STEREOTYPE PRESS. — FIRST STEREOTYPING IN THE UNITED STATES. — DUPLICATE FORMS. — PROCESS OF STEREOTYPING. — MATERIALS USED. — TRIMMING AND PLANING THE PLATES. — THE PAPIER-MACHE PROCESS. — NEWSPAPER STEREOTYPES. — THEIR UTILITY. — ELECTROTYPING. — CHEMICAL AND MECHANICAL PROCESS. — THE MOULDS. — THE GALVANIC BATTERY. — HOW COPPER FAC-SIMILES OF TYPE ARE OBTAINED. — COPPER-FACED TYPE AN IMPORTANT ADJUNCT TO THE ART OF PRINTING.

A STEREOTYPE plate is a fac-simile in type metal of a page of movable type. Its design is to avoid the expense of keeping in type works for which there is a constant demand; to avoid the necessity of recomposition; to reduce the founts of type in the composing-room; and sometimes to print copies of the same work on two or more presses at the same time, or to simultaneously issue a work in two or more different localities. To save the wear of type on the press, and to permit the use of the same type, over and over, in the composition of the successive pages of a book, early suggested stereotyping.

As with many other discoveries, there are several claimants for the honor of this invention. John Muller, of Leyden, stereotyped pages in 1690. A few years later, Van der Mey, of the same city, soldered the bottoms of type together, making them into solid pages. William Ged, of Edinburgh, is credited with the modern mode of stereotyping, which releases the type for re-composition.

William Ged, who was born in Edinburgh in 1690, was not a printer by trade, but a goldsmith, and his attention was first turned to stereotyping in 1725. At that time all the type used in Scotland were cast in London, and it occurred to Ged that a great saving might be effected if solid pages could be cast which would release the type for re-composition. He borrowed a page of type

and began his experiments. In two years he succeeded in making perfect plates; but he had to contend with the prejudices of printers, who fancied that their craft would be ruined by the new process, and, as has been the case with too many inventors, innumerable obstacles and difficulties nearly ruined poor Ged. He succeeded, however, in making complete plates for an edition of Sallust, printed in Edinburgh in 1736. After his death the art was nearly lost sight of till it was revived in Paris in 1795.

The Didots, of Paris, made many important improvements in the art, and Earl Stanhope, of England, invented a most valuable press for stereotype printing. The art was introduced into the United States in 1813, and soon afterwards stereotyping establishments were opened in New York, Boston, Philadelphia, and other cities.

Nearly all the books now published are stereotyped or electrotyped, publishers generally thinking that if a book is worth printing it is worth putting into plates. The plan is also adopted in the case of many magazines and periodicals, since it enables the publishers, by duplicating plates, to run the same pages on two or more presses at once, and, by preserving the plates, to republish particular numbers, or to reproduce an entire series, if there should be a demand for the same. The entire volumes of Punch, up to a certain year, have been republished. The art of stereotyping is invaluable, not only to publishers, but to the general public, in enabling a wider diffusion and cheapening the cost of books and periodicals.

Stereotyping.

When a work is stereotyped or electrotyped, the spaces, "quads," and leads used in composition are of the same height as the stem of the type. The mould for stereotyping requires the finest plaster of Paris, which is specially prepared, is mixed to the consistency of cream, and is poured over the face of the type, which have been previously oiled to prevent the plaster from adhering. The plaster soon sets, and the mould is raised from the type, and is hardened in a heated oven. It is then put face downward on a plate of iron in a cast iron pan, or cover, and is immersed in melted type metal, which runs into the spaces left in the cover, and fills every portion of the mould. This dipping process is repeated so as to allow the gradual and equal contraction of the metal. The result is a stereotype page, which may need some work with the picker and graver to remove imperfections. The edges are then trimmed in a machine; in another machine the

STEREOTYPE FOUNDRY.

back of the plate is shaved or planed to insure the requisite thickness and perfect level; and the plates (if they are cuts, but not generally for letter-press) are screwed upon blocks of wood which bring them to the same height of ordinary type.

Corrections of a word, or a line, or more, in a page, can be made by cutting out the imperfect part and inserting ordinary type, which are neatly soldered in.

Moulds are rapidly made for newspaper stereotypes by what is called the paper process. A newspaper page of type for a cylinder press is in a curved form, in what is known as a "turtle." Instead of plaster of Paris for a mould, moistened sheets of soft paper, pasted together, are laid over the page of type, and are beaten down with a brush till a perfect impression is taken. The mould is dried and hardened, and by pouring in melted metal one or more forms can be made to be printed from. This process is now pursued in several of the larger newspaper offices. The advantages are, first, saving the wear of type, which are used only in composition, and not for printing from; and next, furnishing forms for two or more presses, and thus getting out the entire edition of the paper in the least possible space of time. This invention enables journals to delay the hour of going to press to the latest moment, thus keeping the columns open for the latest news, and yet permitting the publication at an early hour in the morning for distribution and for the mails. The edition printed, the plates may be re-melted, to be run into the moulds for the next day's issue.

Electrotyping.

Electrotyping is now much more common than stereotyping by the process described above. It is a combined chemical and mechanical operation, the processes of which are as follows: The mould is made of pure wax, upon which the page of type is impressed. The mould is then covered with a coat of fine plumbago dust, which is evenly distributed by brushes in a machine, thus giving a conducting metallic medium for the electric current, which is further strengthened by a wash of sulphate of copper over which iron filings are dusted. The result is a thin film of copper coating the entire surface and hastening the subsequent deposit of copper when the mould is in the battery. The mould is now washed, connecting ribbons of copper are attached, and it is suspended from a metal rod in the trough containing a solution of acidulated sulphate of copper. Any number of moulds, according

to the dimensions of the trough, may be put in at the same time. Copper plates are suspended in the solution, facing, but not touching, the moulds. The trough in which the electric current is generated contains sulphuric acid, and is isolated from the trough which holds the moulds. The rods which suspend the moulds in the solution are now connected by wires with the zinc plate in the battery, while the copper plates are similarly connected with the platinum in the battery, and the circuit is completed. Decomposition now begins, and the copper is rapidly and evenly deposited on the face of the mould.

The moulds are left in the trough generally over night, and in the course of ten or twelve hours copper shells are formed on the moulds, giving fac-similes of the pages in type. The inside of the shells is covered with a coating of chloride of zinc, laid on with a brush. Over this is laid a sheet of alloyed foil, and the shell is then "backed up" with inferior type metal to give it solidity and the requisite thickness. This backing is done by pouring in the metal, or by dipping the shell in metal; the face is then laid down on a perfectly level iron plate resting on an iron frame, which must also stand perfectly level, and the superfluous type metal is scraped off. The subsequent processes of trimming the sides and planing the backs by machinery are the same as those described in stereotyping. Corrections can also be made by cutting out and inserting, as in the ordinary stereotype plates.

By means of the galvanic battery type can be copper-faced by presenting only the face of the type to the solution of sulphate of copper in the trough, and establishing the current as in electrotyping on moulds. Type thus faced are very durable, and will wear three or four times longer than common type.

For some work on heavy calendered paper, stereotypes made by the first process described are sometimes preferred; but for the great mass of book-work, and especially for cuts, electrotypes are superior. The invention is comparatively recent, though experiments in electro-plating were made in Europe, with more or less success, from 1801 to 1840, and it is a most important adjunct to the art of printing.

BOOK-MAKING.

ANCIENT BINDING OF MANUSCRIPTS. — THE SUPPOSED INVENTOR. — BINDING IN THE THIRTEENTH CENTURY. — SPLENDOR OF THE SPECIMENS. — PROGRESS OF THE ART. — MATERIALS USED. — GOLD, SILVER, AND PRECIOUS STONES. — BRITISH BINDINGS. — ARTISTS ON THE CONTINENT. — CHEVALIER JEAN GROLIER. — D'EON. — PADELOUP. — CELEBRATED LONDON BINDERS. — ROGER PAYNE AND OTHERS. — FAMOUS MODERN ARTISANS IN LONDON AND PARIS. — BOOK-MAKING IN AMERICA. — THE FIRST BOOK IN BOSTON. — THE EARLIEST BINDER. — PROGRESS OF THE INDUSTRY IN BOSTON, NEW YORK, AND PHILADELPHIA. — BENJAMIN FRANKLIN'S BINDERY. — THE ART. — DETAILS OF THE PROCESSES. — USE OF MACHINERY. — AMERICAN INVENTIONS. — MANUFACTURE OF CASES. — PROCESS OF PUTTING ON. — OTHER KINDS OF WORK. — MARBLING, SPRINKLING, AND GILDING. — EMBOSSING. — BOOK PUBLISHING. — GROWTH OF THE BUSINESS IN THE UNITED STATES. — EXTRAORDINARY SALES OF CERTAIN WORKS. — WEBSTER'S SPELLING BOOK. — "UNCLE TOM'S CABIN." — "SUNSHINE AND SHADOW." — BIBLE DICTIONARY. — BOOKS SOLD ONLY BY SUBSCRIPTION. — USEFULNESS AND POPULARITY OF THIS KIND OF PUBLISHING.

ANOTHER article in this volume (see PRINTING AND THE PRINTING PRESS) gives the history of the discovery of printing, its progress, its introduction into America, and describes in detail the various processes of composition, press work, etc., or, in other words, the preparation of the printed sheets for the binder, who makes them into books. Of course bookbinding was coëxistent with book printing, or rather it is of far greater antiquity, since manuscripts from time immemorial were protected by wood, metal, or leather covers, and the even older books of wood or metal plates were fastened at the backs by thongs or hinges, which furnished a rude binding.

Phillatius, an Athenian, is credited with the invention of sewing sheets of vellum and papyrus together, and securing the backs with glue. Boards or covers would naturally be the next step, and literal boards of wood were first used, which after a while were covered with parchment or leather. The Romans brought the art to great perfection, especially in the ornamentation of the

wooden covers by carvings. In the thirteenth century the monks bound their illuminated manuscripts with covers, which were frequently enamelled, ornamented with gold and silver, enriched with precious stones, and covered with figures beautifully carved in wood. Some of these early bindings exhibit boards an inch or more in thickness, in which were covered recesses for relics and crucifixes. A century later ivory tablets, colored velvets, morocco, vellum stamped with gold, tooling, inlaid calf and morocco covers, and gold and silver clasps and corners, were employed in binding and ornamenting the Gospels and Missals. Many magnificent specimens of the fourteenth and two following centuries — bindings that have never been surpassed in richness and elaboration — are preserved in the great public and private libraries of Europe. A field or farm would scarcely purchase one of these volumes when fresh from the binder, and their value, as relics of by-gone centuries, is even greater now.

The invention of printing made general the use of calf and morocco bindings on oaken boards, and stamped in gold or in "blind tooling." The British Museum has many books bound in England in the time of Henry VII. The period of Henry VIII. produced many magnificent specimens of binding, and under Elizabeth embroidery bindings were introduced. Folios of that period in plain calf show most substantial work.

On the continent bookbinding fairly took rank as a fine art, and early enlisted the attention of true artists. Chevalier Jean Grolier was famous for the elaborate patterns which he drew for his own book-covers; Chevalier D'Eon introduced the Etruscan designs as ornaments; Padeloup tooled books so that they looked as if they were bound in gold lace; and Derome and De Seuil — the latter immortalized in one of Pope's poems — were famous bookbinders. The Cambridge binding of the eighteenth century is justly celebrated. Roger Payne, who began business in London in 1770, may be said to have opened a new era in the art.

Payne was a man of most dissolute habits; but as a thorough artist, especially in finishing, he was far in advance of all who preceded him, and in his own day he had no rival. His success lay in his style, which was original, in his invention and manufacture of elaborate embellishing tools, and in his choice and working of materials and ornaments. Superb specimens of his work are preserved in English libraries, particularly in Earl Spencer's, and bibliographers speak of him in the highest terms of praise. After

Payne, Kalthœber, Staggemier, Falkner, Hering, and Walther deserve especial mention. Mackenzie, Lewis, Clarke (celebrated for his tree-marbled calf), Bedford, and Hayday are among the more famous of modern London binders. All book-buyers know how much the name of a binder sometimes enhances the value of a volume. Trautz, Niédre, Capé, Lortic, and Duru are among the most noted of modern French binders, and their work, for its ornamentation and perfection of detail, is highly prized.

Book-making in America.

The first bookbinding done in the colonies was by John Ratliffe, an Englishman, who came over expressly to bind Eliot's Indian Bible, printed at Cambridge, Massachusetts, in 1661–63, and Ratliffe could bind only a single copy in a day. The first book printed in Boston was in 1676. The early provincial governors were instructed to prohibit printing, which was looked upon as the means of disseminating disobedience, heresies, sects, and libels. But book-makers thrived nevertheless. From 1684 to 1690, Pierce, mentioned as the fifth printer in Boston, published several books for himself and for booksellers. Bartholomew Green followed in 1690, and from that time forward the art has progressed, till Boston has become one of the great book-making centres of the Union. In Philadelphia book-printing began in 1686; in New York in 1693, with the publication by Bradford of the Laws of the Province in small folio. In 1726 New York had a second publisher. When Franklin, a boy of seventeen, went to Philadelphia, in 1723, Samuel Keimer, who employed him, had just started the second press in that city, and besides him the Bradfords were the only publishers in Philadelphia and New York.

Previous to the issue of Eliot's Indian Bible, copies of the Psalms and of the Laws, bound in parchment, appeared in Boston, a copy of the Psalms as early as 1647; but by whom they were printed and bound, or whether the work was done in England, is uncertain. Up to the time of the Revolution there had been thirty binderies in Boston. New York had a bindery in 1769; Benjamin Franklin's bindery, in Market Street, Philadelphia, was in operation in 1729; and two Scotch booksellers in Charleston, S. C., had binderies in 1764 and 1771.

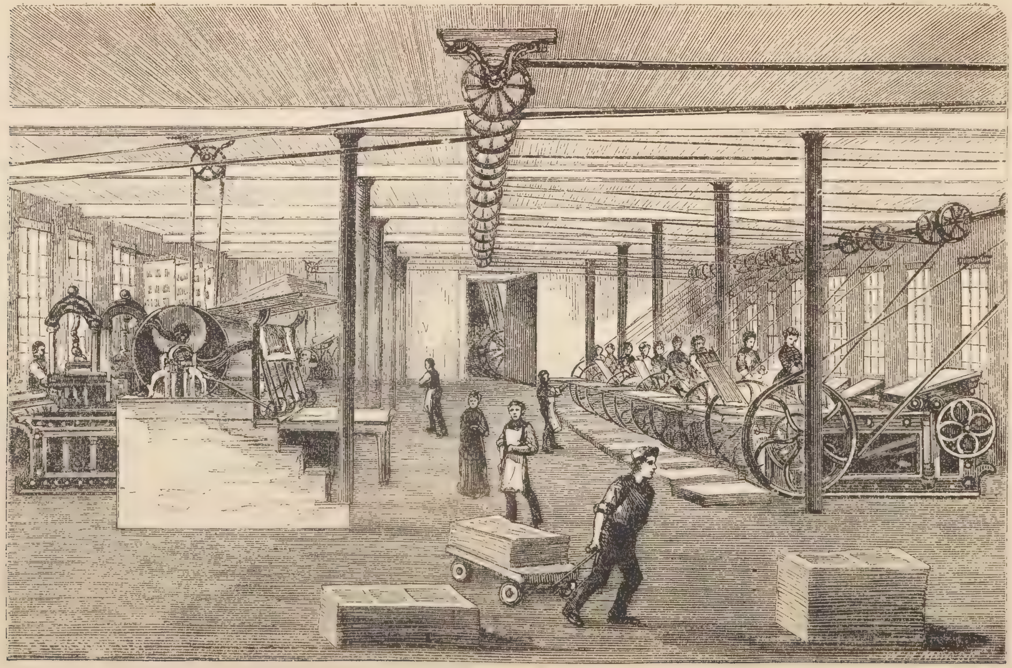
After the Revolution the progress of book-making in the United States was rapid. In 1808 was issued Barlow's Columbiad, in

quarto, illustrated with plates engraved in London, and by far the finest book published in the country up to that time. Two years later Wilson's American Ornithology, in seven volumes folio, with colored plates, was issued in Philadelphia. In 1822 an American reprint of Rees's Cyclopedia was published in Philadelphia, in forty-one volumes, with six additional volumes of plates, and was the greatest venture of the kind which had been undertaken in the country. In 1830 books to the value of three million five hundred thousand dollars, one-third of them school books, were printed in the United States. Since that time, with the increase of population, the general diffusion of education, and the introduction of machinery and other facilities, the growth of the book business in the United States has been enormous.

Processes in Bookbinding.

The printed sheets go from the press to the drying-room, where they are hung on frames in a steam-heated temperature of from one hundred to one hundred and twenty degrees, and remain from half an hour to an hour. They are then placed between press-boards, with a highly-glazed surface; if very nice work, a single sheet between two boards, and sometimes a "set-off" sheet of paper on each side of the printed sheet, but ordinarily three or four sheets between every pair of press-boards. A pile of these boards, with the interleaving sheets, is then subjected to hydraulic pressure equal to six hundred tons for a half day, or in some cases longer. From the hydraulic press the sheets go to the cutting machine, which rapidly cuts them in two. Then most ingenious machines, of different capacity, fold the sheets into pages of the required size and form for a book, making them ready for sewing. The folding gives the name describing the size of a book; thus a sheet once folded into two leaves, or four pages, is a folio; folded again, it is a quarto; folded once more, as in the case of this volume, every sheet gives eight leaves, or sixteen pages, and the book is called an octavo; folding into twelve leaves, or twenty-four pages, makes a duodecimo; and so on for smaller volumes. This folding was formerly done by hand; now one girl tends a machine which will do the work of several girls with great rapidity and accuracy.

The folded sheets are then tied in bundles, till the entire sheets of a single work are folded, when they are placed in order in piles, and a girl going from pile to pile rapidly gathers and collects the



PRINTING THE SHEETS.

FOLDING, GATHERING, AND SEWING THE SHEETS.

pages for a volume, and volume after volume, till the sheets are exhausted. These go to the smashing machine, which has superseded the old method of hammering by hand, and the more recent one of screw-pressing, and instantly presses the pages solidly together. The sawing machine then saws the backs simultaneously, with the four, five, or six grooves necessary to receive the cords through which the thread is passed in sewing the different sheets so as to unite them all together. The books are now carried to the sewing frames, where they are sewed by girls, who perform their work with singular dexterity, deftly passing the needle through each "form," and securing it to the cords at the back. Machines have been invented for book-sewing, but they have not been generally introduced, and the labor is usually, even in the most extensive establishments, performed by girls.

After the sewing, the books are "drawn off," cut apart, and are taken to the trimming machine, which has superseded the old "ploughing" by hand process, and which, with great rapidity, trims the three sides smoothly and accurately. The next process is rounding the backs, which, in large volumes, is done with the hammer, while smaller volumes are rounded by a machine, which carries a roll over the back, and makes them round. A thin coat of glue, previously applied, holds the round in shape. The back is now covered with a piece of muslin nearly the whole length, and extending an inch over the sides, to strengthen the joints, and over the muslin is pasted a piece of paper. The head-bands, consisting of a doubled piece of muslin, and sometimes of knit silk, are put on, and the book is ready to be sprinkled, marbled, or gilded on the edges, though in the cheaper and smaller sized books the edges are left plain, as they come from the cutting machine.

In sprinkling, several books are taken together, secured between two boards, and the color or colors selected are sprinkled with a large brush, or are rubbed through a sieve with a stiff brush, producing the fine dust-like coloring seen on the edges of books. In marbling, the artist — for a skilful artisan in this department is an artist — sprinkles his colors upon a preparation of mucilaginous liquid in a wooden trough, and then with "combs" makes the "comb-work," which is the pattern most usual for the edges. With various colors, and by skilful sprinkling, he makes the different patterns known as shell, — of various colors and differently veined, — blue stormont, light Italian, west end, curl, Spanish of all colors, antique, wave, British, Dutch, and so on, in great variety, for mar-

bling paper used for the sides of books. If the book is to be gilded, the edges are scraped, a groundwork of red chalk is laid on, albumen, or the white of an egg, with water, forms the size on which the gold is laid, and is subsequently burnished with blood-stone and agate. Over this is sometimes laid gold of another color, which is stamped in patterns in the edges, and the superfluous gold of the upper coat is brushed off, leaving the figures.

The "forwarding" process is continued by pressing the books between boards, the brass-bound edges of which make the grooves or joints in the backs for the boards of the cover. In all the cloth-bound books the covers, or "cases," as they are called, are made almost wholly by machinery. The boards are cut to exact size, and the cloth is cut by machinery. The cloth is then stretched, and pasted on the boards; gilding is laid on where the cases are to be embossed and lettered; the embossing presses, which have dies of all patterns, and which are kept warm by steam, quickly impress the designs, and after the cases have gone through the presses seven times, they are finished, the books are pasted and drawn in, and after a final pressing, the completed book is ready for the publisher.

Binding in leather and morocco, or half binding with calf or morocco backs and corners, and paper or cloth sides, requires more hand work. The books are generally laced into the covers; the lettering and the various designs, in gold and blind tooling, are done by hand; and to this binding the only limits are the cost of the work and the ingenuity of the binder. Machinery is much more employed in the United States than in Europe, and most of the ingenious and labor-saving machinery used in bookbinding is of American invention.

The foregoing is designed to give, in the briefest possible manner, an intelligible idea of the ordinary processes of book-making, as seen in the extensive and first-class establishment of Messrs. Case, Lockwood & Brainard, at Hartford, Connecticut.

Book Publishing.

In a work of this kind it would be useless to give statistics of the extent of the book-publishing business in the United States, since it is so rapidly increasing that the figures for one year would give no idea of the business of the year following. It is among the most progressive, profitable, and important industries of the

PRINTING OFFICE AND BOOK BINDERY OF CASE, LOCKWOOD & BRAINARD, HARTFORD, CONN.

country. Mention may be made of single works sold in the United States. Of Webster's well-known Spelling Book more than fifty-five million copies have been printed, the sales now reaching a million and one quarter copies a year, and of the different editions of Webster's Dictionary three hundred thousand copies are sold annually. Of "Uncle Tom's Cabin" more than half a million copies have been sold in the United States; various editions of the same work have been sold in England to the extent of a million and a half of copies; it has been translated into every European language, and even into Armenian and Arabic.

Within a few years an important branch of the business has grown up in the publication of books for sale solely by subscription. By this mode of publication thousands of valuable books have reached buyers who otherwise would not have purchased, and by this dissemination of works of an entertaining and instructive character, intelligence has been diffused, and the country has been benefited. Some of these subscription books have reached extraordinary circulation. Of "Sunshine and Shadow," published by Messrs. J. B. Burr & Hyde, one hundred and fifty thousand copies have been sold; of the Bible Dictionary, seventy-five thousand copies; of other works published by the same house from thirty thousand to one hundred thousand copies of each, and with a steady demand for all. This kind of book publishing is becoming more and more popular throughout the country every year. It is found to be the best, indeed almost only, means of introducing to a large circle of readers, especially in interior towns which are remote from book-publishing and book-selling centres, standard works of a high character, and this means of diffusion, by its enormous extent, enables the publishers and their agents to sell interesting and entertaining works, profusely illustrated, at far less prices than works of the same character can be afforded by the usual method of book publishing.

KNITTING MACHINES.

NETTING AND KNITTING BY HAND. — ANCIENT HOSE. — FRENCH STOCKING KNITTERS. — THE FIRST KNITTING MACHINE. — WILLIAM LEE. — MACHINE-KNITTING IN AMERICA. — PROHIBITION ON EXPORTATION OF KNITTING FRAMES. — COXENDEFER.— MICHAEL TRAPPAL. — TIMOTHY BAILEY. — PROGRESS OF THE INDUSTRY. — THE LAMB KNITTING MACHINE. — WHAT IT CAN DO. — ITS AID FOR THE WOMEN.

The generalizations of modern thought have led mankind to recognize in every interest or occupation which go together to make up what is known as the social forces, a steady process of growth, or progress, analogous to that which in the observation of the physical and mental growth of any child must strike any careful observer. The activity of the child, its ceaseless motions, and its insatiable curiosity are the means Nature takes to force upon him the necessity of becoming acquainted with his powers, and able to use his physical and mental faculties.

He must learn to use his legs and hands to become aware of what he can do and how best to do it. The growth of society is necessarily much slower than that of a child, but the history of the world shows that in government, in finance, in industry, and in every other department of human activity, the course has been the same. The wonderful industrial advance of the present century, the application of steam, of the telegraph, of science to the arts, are evidences that the race, or portions of the race, are becoming acquainted with their powers, and are beginning to use them. The application of machinery to performing the processes which formerly were carried on by the slow and tedious methods of hand labor, is a most striking exemplification of this general principle; and the inventors of modern times, by lessening the time and labor required for the production of the necessities of life, are doing a work that is equal, if not superior, to that of the

moralists, in aiding and stimulating the social and moral progress of society towards a more perfect organization of its forces.

The art of knitting, by which a continuous texture is made from a single thread, intricately joined by a series of loops, was probably in practice at a very early age in the history of mankind. We know that the analogous process of netting, in which the thread is passed over a guard, making the stitches longer and the texture consequently more open, was in common use from the earliest ages. Nets are frequently spoken of in the Bible, and as aids to the hunter and the fisher, are among the most common implements made by the various uncivilized nations at present in the world.

In modern times knitting has come to be the process upon which we rely for the production of various articles of clothing. Stockings were made of cloth, cut out in the required shape, and then sewed, even as late in England as the time of Henry VIII. Howell, in his History of the World, states that this king habitually wore stockings of cloth, "except there came from Spain, by great chance, a pair of silk stockins. K. Edward, his son, was presented with a pair of long Spanish silk stockins by Thomas Gresham, his merchant, and the present was much taken notice of. Queen Elizabeth was presented by Mrs. Montague, her silk woman, with a pair of black knit silk stockins, and thenceforth she never wore cloth any more."

The old term for the garment to cover the feet and the legs was *hose*, a word which is found in Anglo-Saxon, Old and New German, Danish, Lower Latin, and Old French, and which, with the use of the article itself, was derived from the people from whom these different nations descended.

In the middle ages the feet and the whole of the lower part of the body were covered by one garment, the *hose*, which was made entire, and intended to fit the person tightly. Our word *stocking* was introduced with the article itself, and is derived from the Anglo-Saxon word *stocken*, to stick, because the material was made with sticking-pins, or, as we now term them, knitting-needles. Our word *knit* is also derived from the Anglo-Saxon term *cuytan*, an equivalent for which exists in all the European languages, and shows itself how old must have been the knowledge of the art it describes.

On the continent of Europe, as we see in the quotation above given from Howell, the art of knitting stockings was practised long before it was in England. Buchanan, in his History of Inven-

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tions, says that as early as 1527 there existed in France a guild of stocking-knitters. This fact shows that the trade had then been in existence long enough to have become of importance, though as to when it first began to be practised nothing is positively known.

In 1589 William Lee, an educated man, who had been expelled from St. John's College, at Cambridge, England, because he had infringed the collegiate rules by marrying a wife instead of remaining satisfied with being wedded only to the Muses, found himself so destitute that he was obliged to depend for his support upon the scanty earnings his wife could gain by knitting stockings. Observing her at work one day, he conceived the idea of making a machine to do the same work more expeditiously and easily. Having finally succeeded after years of labor in producing a machine which could do the work he designed it for, he made it public; but finding no encouragement in England, he took it to France, where he was seconded by Henry IV. and Sully, and where, after Henry's assassination, he died in 1610.

His workmen, having returned to England with the machine, succeeded finally in introducing its use in London and its vicinity; and shortly afterwards the manufacture of stockings by the stocking frame, as the machine was called, was introduced into Nottinghamshire, which soon acquired the reputation it has retained for this industry. Since then there have been various improvements introduced into this branch of manufacture, until the number of stocking frames in England has increased to over fifty thousand, giving employment, in Nottinghamshire alone, to about forty thousand persons.

By the machine, as originally invented by Lee, the thread was knit in a straight flat web, which, being cut into the proper lengths, was sewed together to make the stocking. An improvement upon this method, the origin of which is unknown, was knitting a circular web, which was afterwards fashioned into the heel and foot in various ways. This process is supposed to have been brought to America by a German who immigrated from Belgium, and settled in Connecticut in 1835.

During the century before, as late as 1784, the existing penalty of forty pounds for exporting a stocking frame from England had been so greatly increased that it had been difficult for the colonies to obtain them. The date of the settlement of this country was almost coincident with the introduction of knit stockings in Eng-

land. Yet Felt, in his Annals of Salem, gives a list of articles to be exported to New England in 1629, among which are eight hundred pairs of stockings, two hundred pairs of which were to be Irish, at thirteen pence a pair in Dublin, and one hundred pairs of *knit*, at two shillings four pence a pair; also "500 pair of redd knit capps, milled, about 5d. apiece," together with "sutes of dublett and hose of leather lyned with oyled-skin leather, ye hose and dubletts with hooks and eyes," and "breeches," or "leather drawers," which for a long time, in New England, took the place of knit hosiery.

The prohibition on the exportation of knitting frames from the mother country forced the colonists to depend upon hand labor for the domestic supply of the demand for stockings and other articles of hosiery. Naturally, too, this labor fell upon the women, and nobly did the mothers and grandmothers of those days meet the responsibility. Up to quite the present century the chief supply of hosiery for the inland population of the country, was produced by the busy fingers of the women in the odd moments of leisure they could snatch from more pressing duties during the day, or during the long evenings of winter.

The subject early engaged the attention of the colonial governments. In 1662 the Virginia Assembly voted a premium of ten pounds of tobacco, the currency of that day, for every dozen pairs of woollen or worsted stockings. When the approaching Revolution intensified the patriotism of the land, the same state offered fifty pounds for every five hundred pairs of men's and women's stockings produced, and worth from one shilling to three shillings a pair, with the privilege of buying them at an advance of seventy-five per cent. upon these prices. Among the German settlers of New York and Pennsylvania this branch of domestic industry flourished naturally. The knitters of coarse yarn stockings in Pennsylvania are said, in 1698, to have received half a crown a pair.

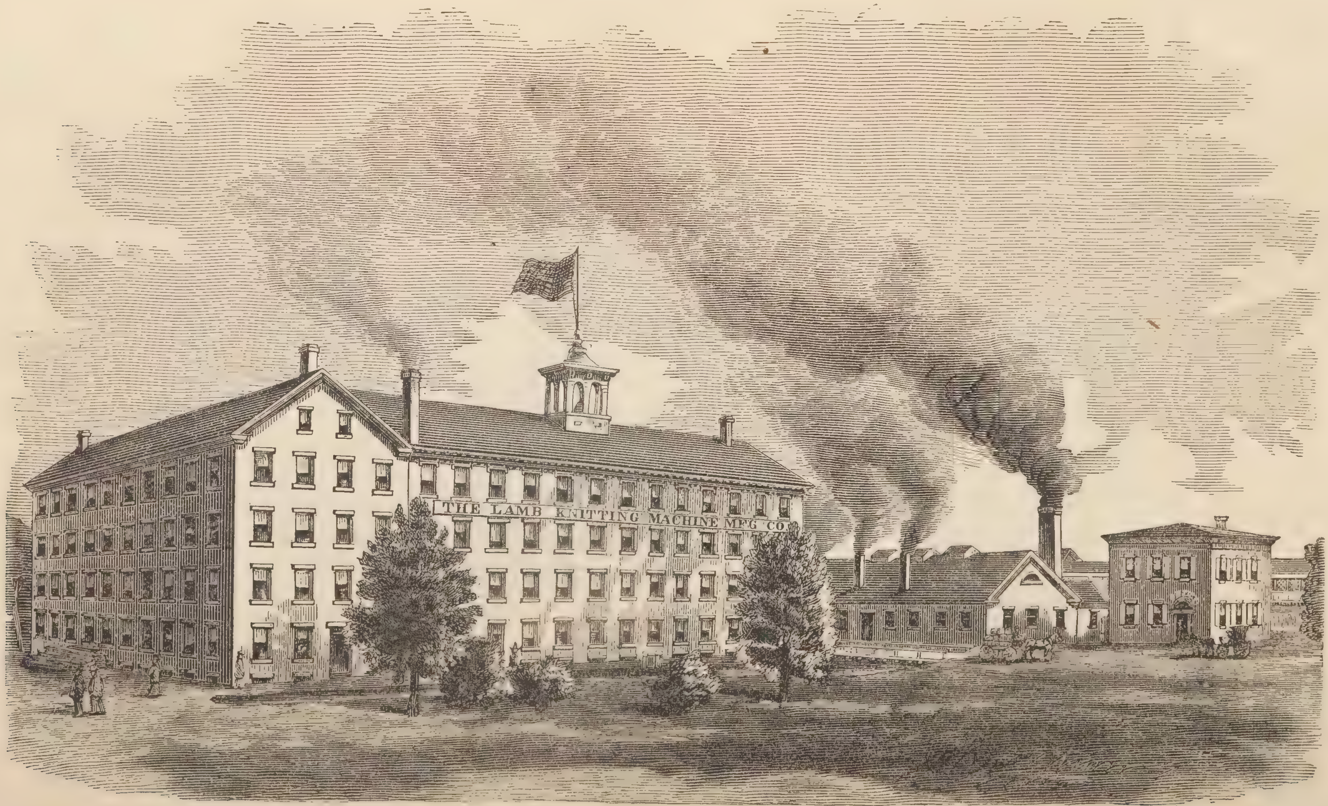
Despite the prohibition upon the exportation of stocking frames, knitting by their aid was introduced into the colonies before the Revolution. The machines were probably introduced by the Germans. The earliest mention found is an item in Bradford's *American Weekly Mercury* for 1723, which speaks of Matthew Burne, of Chester County, Pennsylvania, as having served John Camm one or two years at stocking-weaving, during which time Camm's stockings obtained some repute. In 1776 the Committee of Safety

in Maryland appropriated three hundred pounds to Mr. Coxendefer, of Frederick County, to establish a stocking manufactory. In 1766 the Society of Arts, established in New York, offered a prize of ten pounds for the first three stocking looms of iron set up that year, with five pounds for the next three, and fifteen pounds for the first stocking loom made in the province.

In 1794 Michael Trappal, of Newark, New Jersey, petitioned Congress for an additional duty on hosiery, or some other encouragement of the industry. In the census of 1810 the returns from ten states and territories reported a manufacture of four hundred and eighty-one thousand three hundred and ninety-nine pairs of stockings, valued at five hundred and seventy-two thousand seven hundred and forty-two dollars. Of this Virginia had made almost one half, Pennsylvania, next in order, nearly one quarter, and third, Connecticut.

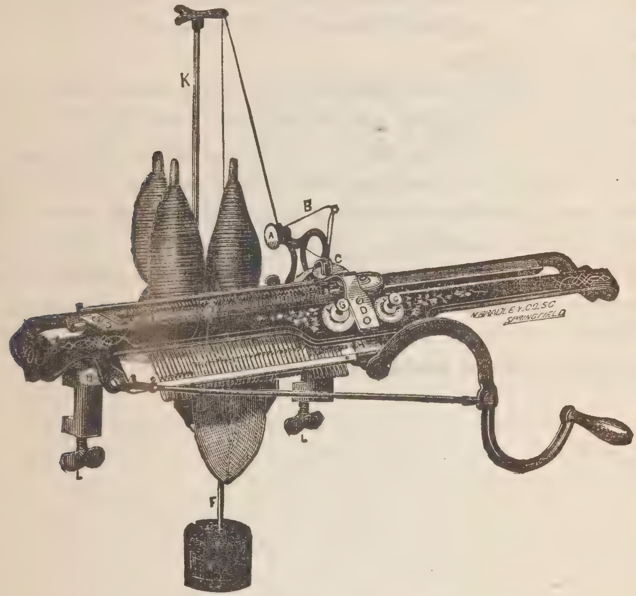
In 1831 Timothy Bailey, of Albany, succeeded in applying power to the old stocking frame of Lee, thus making it a power loom instead of a hand loom. This improvement had been repeatedly tried in England and on the continent, but had been abandoned as an impossibility. This, with the introduction of the machine for knitting a circular web, by which the necessity for a seam in the leg of a stocking was done away with, gave great impetus to the production, since the cheapening, consequent upon this saving of time and labor, greatly increased the consumption. The attention of the inventors being thus turned in this direction, numerous improvements were patented, which were generally intended to improve the machines for factory use.

It is thus that within the last fifty years or so the production of articles of hosiery has been changed from a domestic to a factory industry. Formerly a workman with one of the old hand-power machines could produce in a week about a dozen pairs of cotton hose: now one of the best rotary round power-frames can produce in the same time about two hundred dozen pairs. Against such competition as this the knitting needles, even in the hands of the most skillful grandmother, are powerless. But on the other hand, this method of manufacturing in factories, while it has certainly been of great benefit by cheapening the prices of hosiery, has also done much to deprive the women of a branch of employment of which they had once nearly the monopoly. There is but one remedy which clearly meets this case, and that is the invention of a machine which they could use themselves.



WORKS OF THE LAMB KNITTING MACHINE MANUFACTURING COMPANY, CHICOPEE FALLS, MASS.

This result has been attained by the Lamb Knitting Machine, the invention of Isaac W. Lamb, a Baptist minister of Michigan. This invention gives the women the power to successfully contend against the competition of the factory, without being forced to leave their own firesides, or desert the more congenial sphere of their own homes for the crowded factory. While so simple in



LAMB KNITTING MACHINE.

its construction that any intelligent person can readily become acquainted with its working, it combines the merits of the stocking frame and the circular machine, with the important advantage over both of forming a tubular web in such a manner that it can be narrowed or widened, — "fashioned," as the technical term has it. This result has never been obtained previous to the invention of the Lamb Machine. This, with any variety of plain and fancy ribbed webs, is accomplished by arranging the self-acting latch needles in two parallel rows, and at pleasure, by simple adjustments effected in an instant, operating either row, a part singly for plain flat webs, alternately for tubular, and both together for ribbed or seamed work, and narrowing or widening either web by adding to or subtracting from the number of needles in operation. This is usually done at the ends of the

rows, thus locating the fashioning at two points; but, by manipulating the stitches on the needles, a web can be fashioned at as many points as may be desirable; and this has been applied to a branch of manufacture heretofore done *only by hand*, namely, *heeling and toeing* the ribbed web made on circular machines for mens' and boys' socks. In the ribbed webs, by different arrangements of needles, and transferring stitches, the most beautiful designs can be produced, limited only by the imaginative ingenuity of the operator.

Thus it will be seen that this wonderful little machine (only twenty-six inches long by nine inches wide) will knit all kinds of hosiery, gloves, mittens, &c., completing them with less hand labor than any other machine ever made, and, at the same time, all the fancy articles of wearing apparel, such as scarfs, hoods, jackets, shawls, cardigans, clouds, nubias, &c., and is truly called the companion of the sewing machine. In short, it makes the women, who are the chief consumers of the five or six million dollars' worth of knit goods which are yearly imported into this country, able to produce them for themselves.

WRITING PAPER.

HISTORICAL SUGGESTIONS. — PICTORIAL WRITINGS. — ANTIQUE INSCRIPTIONS. — PARCHMENT. — THE ETYMOLOGY OF THE WORD "PAPER." — THE PAPYRUS PLANT. — MANUSCRIPTS FOUND IN HERCULANEUM. — PAPER IN SPAIN IN 1085; IN ENGLAND IN THE REIGN OF HENRY VII. — VARIETIES OF PAPER. — HISTORY OF THE MANUFACTURE OF PAPER IN THE UNITED STATES. — THE PROCESS OF THE MANUFACTURE. — FINE WRITING PAPER. — ITS DAILY PRODUCT IN THE UNITED STATES. — HOLYOKE, MASSACHUSETTS, AS THE CENTRE OF THE PAPER MANUFACTURING INTEREST. — THE WHITING PAPER COMPANY, THE REPRESENTATIVE MANUFACTURERS OF THIS COUNTRY. — MR. WILLIAM WHITING AND MR. LEVI L. BROWN AS MANUFACTURERS OF FINE WRITING PAPER.

As all our knowledge is derived from experience, the ability to record the results of our thought and observation in such a manner as will enable others to obtain, to compare, and to preserve them otherwise than by verbal communication, is one of the most important, if not the most important, steps made by the race in their advance from isolation to union, or from barbarism to civilization. It has been estimated that under favorable circumstances it would take a people about two thousand years to arrive at some method for expressing language by writing. Of course such an estimate must be very general, since, in a matter of this kind, accuracy of calculation is evidently impossible, the data being merely approximate conjecture.

The first writings were most probably in all cases pictorial, being crude and simple representations of natural objects. In the course of time these drawings came to have merely a conventional resemblance to the objects they were originally intended to represent; and, by an analogous process, abstract ideas were represented by signs, which originally expressed concrete objects. Thus the picture of a lion came to stand for courage, the ox for strength, and finally the suggestion of the picture of a lion or an ox to represent the same ideas.

The researches of modern philosophy into what may be called

the archæology of language have demonstrated beyond dispute that this was, in general terms, the origin and growth of writing, until finally language itself was found to be composed of various sounds variously combined, and these sounds being represented by some arbitrary signs, our various alphabetical systems of writing came into existence. The oldest inscriptions in the world are cut upon stone, or stamped upon bricks before they were baked, or engraved upon metallic plates. These operations are difficult to perform, and the bark or the leaves of some of the tropical trees, which are well adapted for the purpose, were early used to write upon. As it must soon have been found that these substances are too destructible for the permanent preservation of any writing intrusted to them, the ingenuity excited by the demand for some substance which should have the qualities needed, succeeded finally in preparing parchment from the skins of sheep and other animals, together with a fine quality of the same substance, called vellum, from the skins of calves, kids, and still-born lambs.

Though this material possesses in a superior manner the qualities of toughness, indestructibility, and smoothness, which peculiarily fit it for the purpose of writing, yet the necessarily limited supply, and the expense of it, rendered some other material still desirable. This demand was met in antiquity by the manufacture of papyrus, the material for which was furnished by a plant, and from which our word "paper" is derived. This plant, classed by botanists as the *cyperus papyrus*, or the *papyrus antiquorum*, grows on the marshy banks of rivers. It was formerly very abundant on the banks of the Nile, but is said by Wilkinson, in his treatise on the *Ancient Egyptians*, to have entirely disappeared from there. It belongs to the natural order of the *cyperaceæ*, or sedge family, of which the common bulrush and the nutgrass of the Southern States are familiar examples. It has a triangular stem, reaching sometimes the height of twenty-five feet, with its flowers in a cluster about the top. From this stem, cut into sections, the papyrus was obtained by peeling off the inner bark. These strips were then kept saturated with water upon a table, and another layer of them being placed on the first, with the fibres running at right angles, they were joined by pressure, and afterwards hung up to dry. The sheets were enlarged by pasting two sheets together, and such a lengthened sheet was then kept for use rolled upon a roller.

For several centuries after the Christian era a very large com-

merce was occupied in supplying the countries lying upon the Mediterranean with the papyrus made at Alexandria in Egypt. Numerous specimens of writings upon papyrus have been recovered to the modern world from the ruins of Egypt, and from the mummy cases of the dead. In Herculaneum various manuscripts, written upon papyrus, have been found, and some of them have been unrolled and read. Its use, however, was supplanted by that of parchment, and by the discovery of paper. This art was known to the Chinese at a very early date, and was most probably introduced into Europe as early as the seventh or eighth century. Casivi, in his *Bibliotheca Arabico-Hispana*, says that paper was brought to Mecca in 707. The oldest specimen of paper made from linen, known to be in existence in Spain, is a document containing a treaty of peace between the kings of Aragon and Spain in 1178. In the *Chronology of Paper and Paper Making*, written and published by J. Munsell, at Albany, in 1857, this author says that paper mills were in operation in Toledo, Spain, in 1085. In France the introduction of this industry dates back to 1314, and in Germany to about the same period. For Italy the date is given as 1367.

Paper was made in England as early as the reign of Henry VII.; but the first mill of any importance was established by John Spellman, a German, who was jeweller to Queen Elizabeth. The English, however, for the next century still depended chiefly upon the continent for their supplies. The French refugees of 1685 improved and greatly increased the production. In 1760 James Whatman had a mill in operation in Maidstone, the paper from which was of such excellent quality as to create a reputation for its superiority, which has been kept up by his successors, who, in the Exhibition of 1851, obtained a medal for it. During the eighteenth century the paper manufactured in Holland obtained a deserved reputation for its toughness and its solidity.

Paper is of all varieties, according to the various purposes to which it is applied, and also according to different materials from which it is made. For writing and printing paper, however, the chief materials used are the fibres from cotton or linen rags. This material, or that derived from any other source, as wood, straw, pieces of rope, or any other substance with the required fibre, is reduced by various processes to a watery pulp, which, being run out in thin sheets upon felt cloths, the water drains off, leaving the sheet of pulp, which is then pressed, dried, and sub-

jected to other processes, according to the kind of paper to be made. Mr. Munsell mentions in his work one hundred and three different substances from which paper has been made. The large majority of these are vegetable substances, the others being generally animal substances, and the remaining few minerals.

In 1798 Louis Robert, a workman in the factory of Pierre F. Didot, in France, conceived the idea of a machine for improving the manufacture of paper. Up to that time the processes had been carried on entirely by hand. The pulp prepared to the right consistency was dipped out from the vat by the workman into sieves, over the meshes of which he distributed it evenly. No great skill or experience was needed to do this expeditiously and well. Then the film of pulp, being drained, was removed to a cloth, then pressed and dried. The various operations required much time, with some care and attention. Having patented his machine, Robert was rewarded by the French government with an appropriation of eight thousand francs, and sold his patent in England to the Messrs. Fourdrinier, a firm engaged in the stationery business. These gentlemen, having expended about three hundred thousand dollars in experiments for the improvement of the process, became bankrupt. But the results of their self-sacrifice the world possesses to-day in the machine which bears their name, and by which the time consumed in making paper is shortened from weeks to hours.

Roughly described, the process thus introduced is to allow the prepared pulp to flow from the vat upon an endless web. During its passage on this it is partially drained, and this is more effectually done by its passage through rollers. Then it is dried by being passed round drums heated with steam, and is delivered, finished, in a long sheet, which is afterwards cut into the required lengths.

In the United States the first paper mill of which we have any account was erected at Roxborough, near Germantown, Pennsylvania, as early as 1693. This was fifty years after printing had been introduced into the colonies, but only five or six after a proclamation had been issued by the English government for the establishment of the first manufactory of white paper in England. This mill was built by an ancestor of David Ritterhouse, whose family in Holland had long been engaged in the manufacture of paper, and William Bradford, the first printer in Philadelphia. Printing, writing, and wrapping papers were made here until the mill was carried away by a freshet.

In 1728 Bradford, when government printer in New York, owned a paper mill in Elizabethtown, New Jersey, which was probably the second mill erected in the colonies, unless the one upon Chester Creek, Delaware County, Pennsylvania, which was built in 1714, should be so classed. This mill in Delaware County came shortly afterwards into the possession of a Mr. Wilcox, and his descendants quite recently continued the manufacture of paper there by the old hand process. From this mill the press of Benjamin Franklin was supplied with paper; and during the Revolution the bank-note paper used for the printing of the Continental currency was made here by the hand process. In 1829 the old mill was replaced by another, in which paper and bank-note paper have continued to be made in the same way.

Franklin took great interest in the establishment of paper mills, and, after the Revolution, in 1787 stated that he had been concerned in the erection of eighteen of them. In 1769, Pennsylvania, New Jersey, and Delaware are said to have contained forty paper mills, of which six were within the present limits of Philadelphia, and to have produced annually one hundred thousand dollars' worth of paper of various kinds. In 1787 there were sixty-three mills in operation in the states, forty-eight of which were in Pennsylvania, producing all together paper valued at about two hundred and fifty thousand dollars.

The first patent for an improvement in the process of paper-making in the United States was granted to John Carnes, Jr., of Delaware, in April, 1793, for an improvement in the moulds. The second was issued in March, 1794, to John Biddis, of Pennsylvania.

In Massachusetts, according to Salmon in his *Modern History*, a paper mill was built about 1717, and in 1720 paper was manufactured in it to the value of about two hundred pounds. According to other authorities, the generally received statement is, that the first paper mill erected in Massachusetts was built in 1730, by Daniel Henchman, a large bookseller and publisher in Boston, Benjamin Faneuil, Thomas Hancock, and others, who were induced to commence this industry by the encouragement offered by the General Court. By the terms of the license granted them, they were obliged to produce during the first fifteen months one hundred and forty reams of brown and sixty reams of printing paper, and at least five hundred reams, including twenty-five reams of writing paper, during each succeeding year thereafter. In

1731 Daniel Henchman presented to the General Court samples of the paper produced; and in the following year the English paper merchants, learning that the mill was in successful operation, complained of it to the British Board of Trade as an infringement of their business. This mill was built at Milton, about seven miles from Boston, on the Neponset River, and continued until the Revolution in successful operation, though interrupted once or twice by the want of experienced workmen.

During the remainder of the last century, the manufacture of paper gradually increased throughout the country, though the supply never equalled the demand. One of the chief causes limiting the production was the difficulty in obtaining a sufficient supply of rags. The importation of these, together with the attempts to produce paper from various other materials, was stimulated into greater activity by the action of the American Company of Booksellers, who, in 1804, offered gold and silver medals for the greatest quantities and best qualities of printing and wrapping papers made from other materials than cotton and linen rags. In New York and New England the people were stimulated and urged to preserve their rags by advertisements and patriotic appeals in both verse and prose, together with the more seductive offers of three pence a pound for clean white cotton or linen rags, and two pence a pound for blue, brown, or check rags.

During the early part of this century one engine for grinding rags constituted a mill, and two what was called a double mill, and the manufacturer who owned one of these last was counted more than rich. An engine then would grind about one hundred pounds a day. Now an engine will work up from four hundred to fifteen hundred pounds a day, according to its capacity. The paper manufactured then was worth about fifty cents a pound, a price which, comparatively with the present, was equal to about one dollar a pound. The business of paper-making at that time had not become as well organized as at present, and paper-makers were "tramps," as they were called; that is, they were frequently forced, by want of steady employment, to wander over the country in search of it. A mill employed about seven men, and ten to twelve girls.

At this time the custom of drinking was universal, and in the general preparation of the material for the temperance reform of the next twenty years the paper-makers were not behind their fellow-laborers. The ordinary daily product of a mill was about one

hundred pounds. Wages were paid in cash, or in equivalent trade in goods, as needed, settlements being made about once a year. The rate of wages ranged from twenty-five cents to five shillings (eighty-three cents) or to a dollar a day. A dollar and a quarter a day was large pay for a superintendent.

Women then, as now, were paid less for the same work. Their wages averaged a dollar and a half a *week*, of which one half was paid in cash and the other in board. There was no social disgrace in working in the mill, and the daughters of the best society the place contained were often employed in the mill. The work was all done by hand, the pulp being dipped out into the "mould," which was just the size of the sheet to be made. Two men and a boy were required for the dipping from the vat, the couching, or laying off on the "felt," and separating from the felt.

When a pile of one hundred and twenty-eight sheets had been made, they were pressed together in alternate layers with the felts by a common screw-press. The paper was then removed from the felts, and pressed again and again, until the water was expelled. The next day the girls "parted packs," that is, separated the sheets, which were again pressed, and again parted, and then hung up, in sections of six to ten sheets, in a loft to dry. When dry, the sheets were evened, or "jogged," as the term was, then sized in packages of about one half ream by being dipped into a thin glue, then pressed again, and the edges turned to prevent their sticking together, then parted, pressed again, and hung up again to dry. When dry they were pressed again, assorted, the specks and motes picked off with a sharp knife, then pressed again with sheets of paper between them, and then again between hot plates of iron. The edges were then trimmed even with a binder's plough, and the paper was packed for sale.

Steam power was first applied in the United States at Pittsburg in 1816. The introduction of the Fourdrinier machines has greatly facilitated the manufacture, and made the production of modern times able to satisfy the increased demand caused by the wonderful industrial advance of this century. These machines cost about twenty thousand dollars each, and kept at work the twenty-four hours of a day, make two and a half tons of paper. A part of the new process in its manufacture is the use of chlorine in bleaching and cleaning the rags, and rendering it possible to use coarser materials for the production of the better qualities of paper.

The general statement of the workings of this machine has

already been given. It would be almost impossible, without numerous illustrations, to describe intelligently its technical arrangements. The machine occupies a space of eleven hundred square superficial feet, and a continuous sheet, which commences as pulp, and is delivered as paper, occupies, in its intricate passage through the various operations of manufacture, a length of over one hundred feet, or over six rods. After the paper is made, it is calendered, which consists of rolling it between a smooth copper roller and one made of paper, this last material being the best substance known for giving a smooth surface. These rollers are pressed together with great force, and the effect is to greatly strengthen the paper. When finished and arranged in reams, the paper is stamped with any device by means of dies.

The manufacture of fine writing paper in this country is prominently among its great industries, some sixty-five tons a day being the customary product, a large percentage of which is made at Holyoke, Massachusetts, where exists the representative or leading paper manufactory of the Whiting Paper Company, whose paper is so extensively used throughout the United States, and appreciated for its delicate finish and general perfection.

The Whiting Paper Company, though not old as a corporation, has won for itself the first place among paper manufacturers with a rapid and sure success rarely equalled in any business enterprise, through the happy combination among the gentlemen composing it, of peculiar talents for the business, great energy, thorough experience, and large capital.

Mr. William Whiting, after whom the company is named, is still a young man, one of the few who win early successes. Though young he has had long business experience, and enjoys an extensive acquaintanceship throughout the country. With untiring energy he devotes himself to the active business of the vast establishments owned by the company, while he has the co-operation and invaluable counsels of his chief partner, Mr. Levi L. Brown, whose perfect acquaintance with the business in every detail, and unequalled success as a paper manufacturer (at South Adams, Mass.), long since secured to him a cordial deference among paper manufacturers as the leading man of their order in the United States.

Such men, who could not fail to do credit to any enterprise in which they might engage, are likely, especially as they are in the full vigor of life, to long hold the leading position in their manufacture, which they have so worthily obtained.

GLUE.

ISINGLASS IN THE LAST CENTURY. — EARLY MANUFACTORIES IN THE UNITED STATES. — SOURCES OF ISINGLASS. — HOW IT IS MADE. — ITS VARIOUS USES. — FOOD FOR INVALIDS AND DELICACIES FOR THE TABLE. — GLUE. — MATERIALS FOR MAKING IT. — HOW THE GELATINE IS EXTRACTED. — CUTTING GLUE INTO SHEETS. — DELICATE WORK. — WATCHING THE WEATHER. — SEASONS FOR GLUE-MAKING. — FINAL PROCESSES. — DRYING, GLOSSING, AND PACKING. — LIQUID GLUE. — MARINE GLUE. — THE PIONEER GLUE-MAKER — PETER COOPER. — HIS HISTORY AND ENTERPRISES. — HIS INVENTIONS. — A GIGANTIC GIFT TO A GREAT CITY. — THE COOPER INSTITUTE. — FREE EDUCATION FOR EVERYBODY. — WHAT GLUE HAS DONE FOR NEW YORK.

THE glue business in this country began with the manufacture of isinglass before the revolution, this branch of industry having been stimulated by premiums offered in England for the production of isinglass in the colonies. In 1824 this manufacture was begun and carried on at Gloucester, now Rockport, on Cape Ann, where the article was made, mainly for cotton manufacturers, from the hake fish. For some years Gloucester was the sole seat of the business; but now the manufacture of glue for edible and mechanical purposes is extensively pursued in the United States.

Isinglass is nearly pure gelatine, obtained from the sounds and air bladders of different kinds of fish. The Russian isinglass has the best reputation, and is prepared from the sound of a species of sturgeon known as the "beluga." The sound is cut open, washed, and the inner membrane is removed, dried, and becomes the isinglass of commerce. If pure, it is, when prepared, colorless, transparent, and odorless, excepting, sometimes, a slight odor like that of sea-weed. It comes to market in various forms — "leaf," "book," and "long" or "short staple." It is fish glue; and, if prepared for edible purposes, it readily dissolves in hot

water, giving a fine jelly of any consistency, according to the quantity of water and isinglass used. It is usually refined before it is sold for blanc-mange and jellies. Nearly all maritime nations make and export isinglass of different qualities, all inferior to the Russian, and all requiring selection, cutting out of colored and imperfect parts, and refining before it is offered at retail. In the New England States and in New York isinglass is made from the sounds of the hake and the cod, and, refined, it is a superior article.

Its uses are many: for invalids it affords a most agreeable nutriment, and, for the table, according to its preparation, different delicacies. In thin, transparent sheets, it is used as tracing paper to copy engravings; it is employed to clarify liquors; it is worked up in artificial flowers; it makes a strong cement for mending glass and porcelain; it forms the capsules which hold nauseous medicines, and disguise their taste; it has been used in making moulds for statuettes, which were also made of the same material; and is useful in many other ways.

The glue of commerce is simply impure gelatine, which may be made from various kinds of animal matter, but requiring the greatest care in the process of manufacture. Bits of skins, hides, untanned leather of all kinds, tendons, entrails, hoofs, and even bones, afford more or less gelatine, and furnish the material for glue. The process is to macerate the material in tanks or vats, with frequent applications of lime-water, for two or three weeks. The mass is next taken out, and spread in thin layers on a sloping platform to drain, and turning it over occasionally assists the drying and removes the quicklime. Then comes the "digesting," which is done in copper boilers, with double or false bottoms to prevent the fire from injuring the animal matter. With steady, but not violent boiling, and repeated stirrings, the mass soon gives out the gelatine fluid, which is evaporated to the proper consistency, and then drawn off to settle and to be clarified. Second and third boilings give an inferior quality of glue and liquor, which is used instead of water in boiling other animal matter; the final refuse makes good manure.

When the impurities have settled and the glue has been clarified, it is drawn still warm into wooden boxes to cool, and in a few hours it can be cut with spades into blocks, which are transferred to other boxes, in which they are subsequently cut by wires into

sheets; or the blocks may be turned out on a table and cut to the desired thickness.

Now comes the most delicate part of the entire process, requiring the constant watchfulness of the workman. Careful handling skilfully places the sheets on nets stretched in wooden frames, so that the air can reach the glue on all sides, and the sheets must be turned several times in a day. Not only the glue, but the weather must be watched. Thunder storms will frequently destroy the coagulating power; damp weather moulds the sheets; cold weather freezes the water in the sheets, and causes them to crack; hot weather may also crack them by causing them to dry too quickly, and by making the contraction uneven; fogs, even, may induce mould; and with these numerous contingencies glue-making is generally carried on in the equable weather of spring and autumn, though in the best weather the workmen must be ready to shut all the doors and windows of the drying-house at a moment's notice. Sometimes, in a warm day, the sheets will soften and run through the meshes of the nets, in which case it must be melted over again and cut into fresh sheets.

Further and final drying is effected by artificial heat of a high temperature. The glue is glossed by dipping it in hot water and rubbing it with a moist brush. After a day's drying it is ready to be packed. The glue is of different qualities, according to its purity, color, hardness, etc. When used, it is broken up, soaked for some hours in cold water, and then softened, not by boiling, but by the heat of the surrounding water in the ordinary double glue pot, the hot water keeping the glue liquid while the carpenter or cabinet-maker is using it.

A few years ago, a shrewd "Yankee," by profuse advertising, managed to furnish nearly every family in the country with a little bottle of "prepared glue," requiring no heating, always liquid, and ready for use,—a "good thing to have around the house," and really an excellent article with which to mend furniture and other wood work, or to use on the office desk as a strong mucilage. This was common glue, made liquid by the addition of nitric acid; and for the benefit of those who desire to engage in the manufacture for domestic use the formula may be given, viz., ten ounces of nitric acid to two pounds of glue dissolved in a quart of water. The addition of shellac and India rubber, dissolved in oil of turpentine, to common glue, results in what is known as marine glue, which is very adhesive, and insoluble in water.

Peter Cooper.

Peter Cooper, of New York, the well-known inventor and philanthropist, who still (in 1871) lives in good health to enjoy the large fortune accumulated by his intelligence and industry, was the pioneer in the glue manufacture of the United States. He was born in New York city in 1791, and, with very limited opportunities for education, he became, at the age of seventeen, an apprentice to a coach-maker, who offered, when the apprenticeship expired, to set up young Cooper in the business. He declined, and after working a while at his trade, he was subsequently, in succession, a manufacturer of cloth-shearing machines, a maker of cabinet-ware, and a retail grocer. He then began the manufacture of glue, which he followed for thirty years, accumulating an enormous fortune, while Peter Cooper's glue and isinglass were known as pure and trustworthy articles the wide world over.

This remarkable, and always active and energetic man, afterwards engaged extensively in the manufacture of iron. He was the first who succeeded in puddling iron with anthracite coal; he was first to roll iron beams for buildings; he built, from his own designs, the first locomotive in this country, and it was used on the Baltimore and Ohio Railroad. He early interested himself in the electric telegraph, in which he has large investments, as well as in Atlantic cables. He has always been ready with his advice and purse to push forward the great industries, inventions, and improvements in which he was interested, and few men are more thoroughly identified with the progress and prosperity of the country.

Mr. Cooper has built his own monument, which will make his name a perpetual memory in New York. This he has done,—wisely while he was yet living, so that his intentions and designs might be subject to no misapprehension or distortion by his executors,—by founding a "Union for the advancement of Science and Art," which is known as the "Cooper Institute." This is a magnificent building, at the intersection of Third and Fourth Avenues and Eighth Street, in New York, erected at a cost, with the land, of half a million of dollars, and devoted forever to the instruction of the young in that city. The stores beneath the building, the revenue from the large public hall, and other funds given by Mr. Cooper, afford an income abundantly sufficient to support the large, liberally supplied, and constantly thronged reading-room,

the library attendance, the various schools of art, science, and languages, in the same building; and the founder has since given large sums of money to special objects connected with this generous and gigantic gift to the city. The student, the mechanic, the laboring man, can find in the Cooper Institute, free of cost, the means for education and entertainment. The School of Art and Design, and other departments, also furnish instruction to young women, who are thus qualified to sustain themselves; the library, especially valuable in scientific works, is constantly increasing; new departments of instruction are from time to time added; and the whole scheme, magnificent in conception and complete in its carrying out, is foremost among the public educational opportunities and enterprises in New York.

Glue was the beginning of the great fortune, a portion of which has been thus expended; and thus much glue has done for New York city as well as for Mr. Cooper.

VENEERING.

THE ART KNOWN TO THE ROMANS. — ITS UTILITY. — THE PRINCIPAL WOODS USED. — SELECTION OF ABNORMAL FORMATIONS. — DEFORMITIES TURNED TO BEAUTIES. — PROCESS OF SPLITTING AND SAWING VENEERS. — UTILIZING SAWDUST. — DELICATE MACHINERY. — THINNESS, WIDTH, AND LENGTH OF VENEERS. — STRIPS OF IVORY. — PROCESS OF PUTTING ON VENEERS. — APPLICATION OF THE ART. — BUHLWORK. — PRESSED WORK. — BOOK-BINDERS' BOARDS. — WOOD HANGINGS FOR WALLS.

VENEERING is the art of facing straight-grained, inexpensive wood with a thin strip or plate of beautiful and costly wood, so that the cabinet work or other article, when finished, may present the appearance of having been made from solid boards of the more expensive material. The art is very ancient; it was known centuries ago to the Romans, and, possibly, to the Egyptians, to whom it naturally would be suggested by the plating of wood with gold and silver, in which they were experts. Obviously, the first intent of veneering is to deceive — to represent as solid substance what is only surface; but it enables the purchaser to procure what he desires in furniture, panels, casings, and other wood work, at a far less price than the same work from the solid material would cost; and the art has the intrinsic advantages of strengthening, by means of the veneer, the wood basis, so as to materially assist in preventing it from warping or splitting, and of permitting the artisan to make perfect matches in parallel panels, or in one design in a single part of his work, by using two faces of the same cut, thus producing exact duplicates, which would be impossible in the solid wood.

The principal woods used for veneering are the American bird's-eye maple, ebony, mahogany, rose-wood, king-wood, satin-wood, sandal-wood, sycamore, kiabocca (or amboyna), zebra-wood, tulip-wood, and a few others. From these woods sections can be selected which present knots, gnarls, or other excrescences, which,

when sawn into strips, present surfaces showing beautiful and variform figures. In parts of the trunk where limbs have protruded, the veneers will give elliptical figures, sometimes two or three feet in length, by from four to six inches in breadth. In such parts of the tree the fibres not only assume a vast variety of twists and shapes, but they acquire deeper colors, and, by interlacing the texture, the wood becomes denser and more compact. Other parts of the same wood exhibit a wavy and grotesque appearance, or that mottled surface seen in the bird's-eye maple, and the similar, though far more beautiful and costly, kiabocca. These dots or "eyes" are incipient or partially formed knots. The knots and excrescences turned into veneers furnish the endless and pleasing varieties of shapes seen in finished furniture and cabinet work, and what in nature is in reality a deformity becomes beauty of a high order in art.

The veneers are sawn or cut by machinery from blocks or planks of the wood. For straight-grained woods there are ingeniously constructed machines which will split the veneers of the required thickness, thus utilizing the whole of the wood and saving the waste (estimated at one eighth) made by sawing. But for the more valuable woods, this sawdust need not be wasted, since it can be mixed with glue or bullock's blood, and then forced by powerful pressure into moulds which will give beautiful imitation wood-carvings of solid texture. The greater part of the veneers are sawn by machines which must be of the nicest construction, for the veneers vary in thickness — according to the material or the value of particular woods — from eight to one hundred veneers to the inch in thickness of the plank or block. The veneers vary in width from a few inches to four or five feet. By still another machine veneers of considerable length as well as width are obtained. This machine is, in fact, a turning-lathe, which cuts the veneer from the wood in a spiral, so that the strip comes off as it were from a roll, in a sheet of from ten to fifty feet in length. This is applied especially to bone and ivory, and sheets of ivory have been cut by this method of from ten to forty feet in length and from one to two and one half feet in width. Perfect machinery enables the veneer mill to supply the cabinet maker or other artisan with uniform veneers of the required thickness for different classes of work.

The veneers are sent to the cabinet maker rough on both faces, and the surface to be placed on the wood is further roughened to facilitate the gluing. The strips are selected and shaped to the

part to be veneered; the wood work ground is thinly coated with glue; the veneer, well warmed to keep the glue liquid, is laid on; over the veneer is placed an exactly-fitting wooden cover, or "caul," also warmed, and caul and veneer are then tightly pressed down by wooden clamps secured by screw bolts and nuts. Or the veneer may be placed, rubbed down by hand, and then pressed down by the "veneering hammer" worked by one or more men from the centre to the edges, so as to press out air and any excess of glue. In this process the glue is kept in a fluid state by hot size on the surface of the veneer. Such spots or places as do not adhere closely are "gone over" with a hot iron. When contact is perfect, and the work is thoroughly dry, the veneering is finished, as in other cabinet work, by planing, scraping, polishing, oiling, or varnishing with colorless varnish. The finished work acquires a darker, and so older, appearance by exposure to light, and the same effect may be produced artificially by the use of lime water.

The application of the art is almost unlimited. It is seen in furniture of the commonest and of the most costly kinds; in the ivory keys of pianos; in panellings, and cabinet and carpenter work of various sorts; and in the elaborate interior fittings of halls, offices, and libraries. It is exhibited in its most perfect form in the mosaic, or inlaid work known as "buhlwork" (probably the most ancient style of veneering), in which rare woods, ivory, tortoise shell, and other materials are inlaid or veneered in fanciful and beautiful forms. A recent American invention utilizes veneering in what is known as "pressed work," which consists in gluing together several veneers of a cheaper wood, say black walnut, facing them with more expensive wood, like rose-wood, and then heating the whole and shaping it in moulds to furnish chair backs and arms, or other curved work. By this process, a stronger piece, less liable to crack or warp, is secured, than could be obtained from a solid plank. By similar processes, heating and putting into moulds, an infinity of shapes may be obtained from veneers, which are thus made to present forms and figures in relief, as if of carved wood, the concavities being filled with composition to make the work solid. Veneers are sometimes cut and stamped for binding books; and large, thin sheets of variegated woods have lately been introduced in the United States to take the place of paper hangings. Properly put on the wall, a room presents the appearance of having been finished in the solid wood from which the veneers are cut.

EDUCATION: ECONOMICAL AND EFFICIENT.

THE EDUCATION BUSINESS. — EIGHT MILLION CHILD-PATRONS. — GIGANTIC CAPITAL INVESTED. — TWENTY-SIX HUNDRED SCHOOL-BOOKS. — NO HISTORY OF EDUCATION. — PRACTICAL TENDENCY OF EDUCATION REFORM. — OBJECT-TEACHING TWO CENTURIES AGO. — A QUART OF BLACKBOARD. — OLD-FASHIONED SCHOOLS. — REBELLION AGAINST GRAMMAR. — THE REAL ROYAL ROAD TO KNOWLEDGE. — FIRST ORGANIZATION OF THE IMPROVED SCHOOL APPARATUS BUSINESS. — ORIGIN AND RISE OF THE HOUSE OF J. W. SCHERMERHORN AND CO. — EXTENT OF THEIR OPERATIONS. — CONTENTS OF THEIR MUSEUM. — MODERN APPARATUS. — MASTER TILESTON AND THE PEN-WIPER. — PUBLISHING DEPARTMENT.

IMPROVEMENTS in the methods and in the machinery of education and schools have a value in a mental and moral point of view which has been endlessly talked about, and is pretty well understood. But their importance, as a matter of every-day business, in dollars and cents, is not so often mentioned, and is less familiar. And yet the business part of education, even leaving the matter of "soul" for the moment out of the question, ranks, in point of money importance, in the same grade with the cotton business, the woollen business, the grain trade, or the shipping interest.

That this is so will quickly be perceived, if we only remember that about one fifth of the whole number of persons in the United States are always occupied in attending schools or other educational institutions; that is, at present, not far from eight millions of pupils, besides about one hundred and sixty thousand teachers. The books alone used by this vast army at any one time have cost at the very least twenty millions of dollars; the seats, desks, and other apparatus, thirty millions of dollars — together, fifty millions of dollars. The investment of capital in school-houses and other buildings, in lands, college endowments, etc., is several times as much as this; one single item, viz., fifty millions of acres of

public lands, given by Congress at one time for educational purposes, being alone equal in value to the items of books and furniture. To all these must be added, further, a capital the interest of which would equal the annual total sum paid to teachers; a still further considerable item for libraries; another for reference-books and professional works owned by teachers; and the total amount of the business investment of the United States in education becomes absolutely gigantic.

Perhaps another fact will add to the distinctness of our picture. It is well known that as much as twenty thousand dollars has repeatedly been invested in preparing, printing, and distributing some single new school-book before the receipt of any returns from it, with the expectation that subsequent sales would reimburse the whole, with abundant profits. Very well: there are in the market to-day (besides books which have become obsolete) about twenty-six hundred different school-books. Of course the investment for "introducing" these has often been comparatively small; but if there are so many competitors for a patronage which it may cost so much to obtain, that must be an enormously lucrative patronage.

No competent history of education exists in English literature. German literature contains many works on the subject, and abundant materials for it are dispersed throughout English literature, particularly in the essay and biographical departments. But any one at all versed in the general subject will recognize the truth of the statement that, since the time of the "revival of classical learning" in Europe, which took place just after the capture of Constantinople by the Turks, and just before the Protestant Reformation, one line of progress more distinct than any other can be clearly traced along the whole history of modern education — namely, improvement in the *practical* character of education.

This practical tendency has always belonged to the prominent educational reformers, and has characterized all the improved educational systems, as compared with those which preceded them. We find Comenius, in the days of Oxenstiern and the Thirty Years' War, laying down with perfect distinctness the very doctrine which is to-day most prominent among the improvements now in progress, to-wit, the Object Lesson system. He says, "Things and words should be studied together; *but things especially*, as being the object both of the understanding and of language." This same idea, indeed, was the basis of his famous *Orbis Pictus*,

a collection of pictures of natural objects with explanations, in connection with which he intended that the objects themselves were to be used as far as possible. This work has been a favorite German school-book for two hundred years — a duration of popularity more than doubling that of Webster's Spelling-Book.

To pass at once to the affairs of the present day. The condition of the educational interest of the United States, so far as it is to be looked at on the business side, presents two especially striking features. These are — first, the rapidly advancing practice of educating through the senses, and about things instead of educating about words, and through the memory; and as a means of accomplishing this, the increased use of improved apparatus of all kinds, from the school-house itself with its symmetrical and elegant furniture and fittings to models and machinery of all kinds, and even down to the minute details of crayons, erasers, rods, inkstands, and hat-pegs; and second, the use of capital, machinery, and inventive ability for supplying these improved instrumentalities at once in great quantities and at cheap rates — that is, according to the spirit of modern civilization.

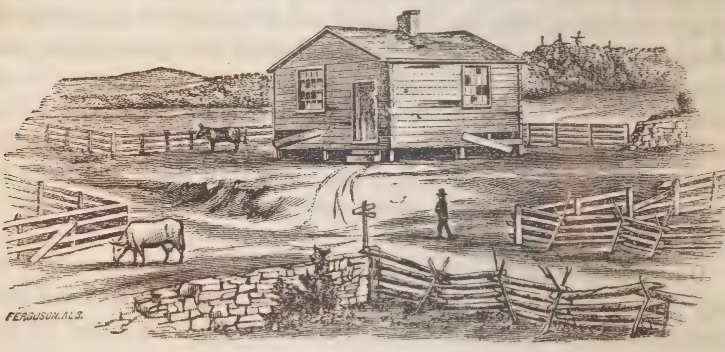
One question, to-day a perfectly reasonable one, but which at any past period in the history of schools would have been perfectly absurd, may serve to illustrate the changed character of the new order of things: —

"What is the price of a quart of blackboard?"

Heretofore we might as well have inquired for a yard of oil, or a pound of conscience. But it is no joke at all; a material is regularly manufactured and extensively used, which is neither more nor less than liquid blackboard. It is bottled or canned for carriage and keeping; may be spread like paint on board, paper, or wall, and becomes a blackboard.

The old-fashioned "district school" has, within the memory of very many persons now living, been the prevailing type of school-house and apparatus; and, indeed, abundance of specimens of it may yet be found. It is a clapboarded shanty, or perhaps a log hut; its walls within fringed, so to speak, with a sloping board for a desk, while parallel to this are slabs for seats, upheld by straddling legs cut from green poles, with the bark still on them. Perhaps other desks and seats, on the same principle, occupy part of the floor. Each pupil has a speller, a reader, an arithmetic, and possibly a geography and atlas; perhaps there is a blackboard, and very likely there is a rattan, a ferule, or even a raw-

hide within reach of the teacher's hand. No wall maps; no globe; no apparatus of any kind, unless a painted pail and a tin dipper may be called such, for illustrating hydraulics and hygienics at once. As for a school library, or any real "apparatus," as well expect to find a grand piano growing in the woods. It has happened within the last twenty years that a rebellion broke out among the intelligent parents of a certain school district in the educationally famous State of Connecticut, because the teacher ventured — not to make the district pay for globes, or maps, or pictures, or anything else, but — *to teach grammar!*

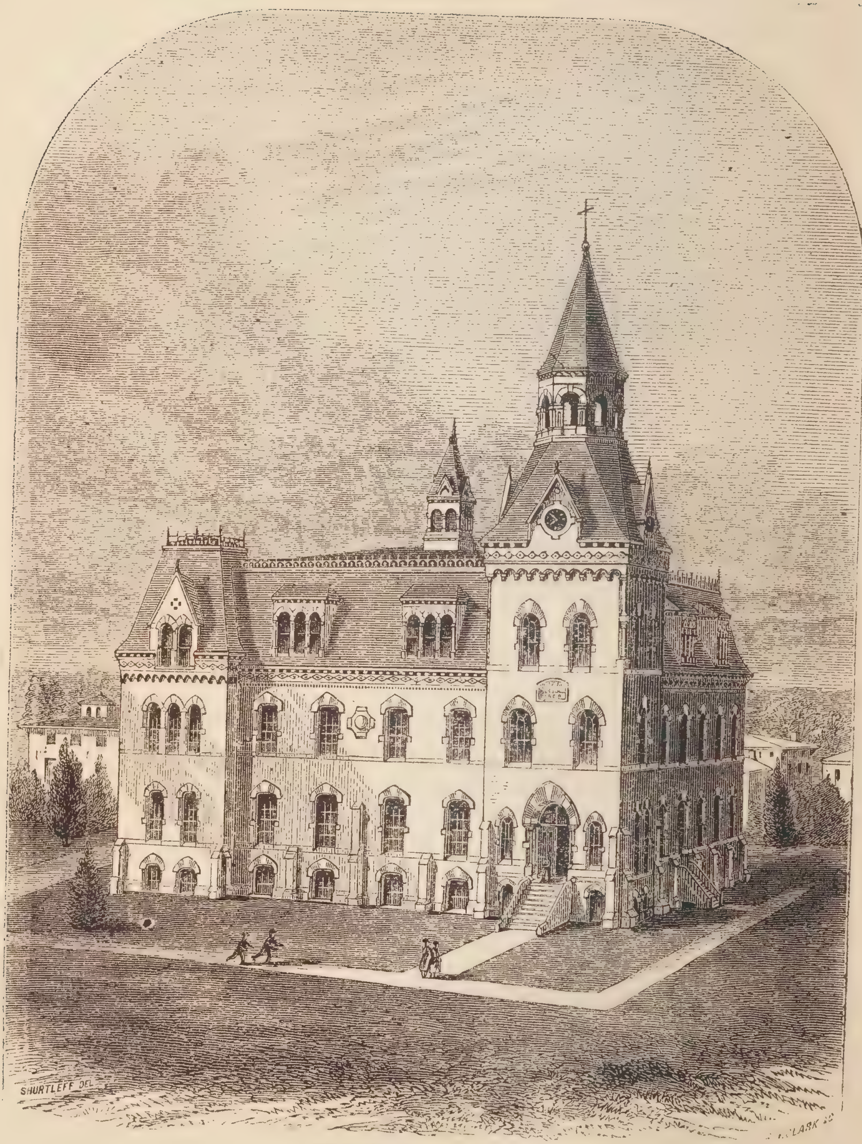


THE OLD-FASHIONED SCHOOL-HOUSE.

However, the number of such abodes of darkness decreases. The present spirit of the schools is represented by a very different affair — by the first-class graded school, with its elegant architecture, home-like and healthful warmth and fresh air, neat and comfortable desks and seats, abundance of text-books, well-chosen library, varied assortment of maps, charts, globes, and primary and scientific apparatus of all kinds, in short, by an array of contrivances for shortening, clearing, and easing the way of the scholar, and for speeding his progress upon it, so numerous and so effective that the time-honored maxim, "There is no royal road to knowledge," is pretty much done away. There is one; it lies through the improved common school; and the sovereign for whom it has been contrived is the Sovereign People.

Unquestionably the utmost point thus far reached in this process of organizing and combining for the supply of mental training on business principles is shown in the existence and operations of a central depot for exhibiting and distributing school material.

MODERN DISTRICT SCHOOL.



MODERN HIGH SCHOOL.

Fifteen years ago no such depot existed. The boys and girls in the country could get their spelling-books, arithmetics, and slate pencils where their fathers bought their codfish and molasses, and their mothers their calico and thread — at the country store. In the cities there were publishers and booksellers, in case of a wholesale order for the like commodities. But it was not easy to obtain much more. Some of the simpler articles of school apparatus, now in common use, were not unknown, but, in order to obtain them, the enterprising teacher or trustee must visit as many different places as there were articles named on his memorandum. Prices were high, the supply small, and the shops or garrets where each article might be had were obscure, and dispersed throughout the city. Of course these articles were usually not supplied, and the efficiency and improvement of the schools were seriously impeded accordingly. A few feeble attempts had been made to establish the manufacture of some of the most important apparatus, but without enough of either capital, or energy, or knowledge of what was required to attain success.

In 1858 a schoolmaster, now principal of the house of J. W. Schermerhorn & Co., of New York, having learned in his professional experience the wants of the schools, and having studied the needs of the times, conceived the idea of a general depot for school material of all kinds. In this one centre, according to his conception, should be gathered and displayed specimens of furniture, apparatus, stationery, books, — everything useful in the school-room. It was to be an exhaustive museum of educational merchandise, where all things in that line could be seen by all men — and women ; in fact, a perpetual world's fair of school material.

In 1859 a connection was made with the American School Institute, and the proposed business was actually set on foot in Philadelphia. In 1861 it was found expedient to remove the base of operations to New York. It quickly became evident that, in order to adequately develop the enterprise, a department for the manufacture of school merchandise must be added. Mr. George M. Kendall, who had been identified with the enterprise from the first, assented to the suggestion ; in 1865 Mr. George Munger, an inventor of celebrity, whose articles had been extensively ordered through the house, joined it as a partner, and manufacturing was soon afterwards begun at Guilford, Conn. Mr. W. P. Hammond joined his interests with those of the gentlemen already named, and not long afterwards three enterprising capitalists — Messrs.

Nelson Crawford, Thomas Bell, and Samuel P. Bell—invested funds in the house.

No gigantic fortunes have yet been made in the operations of this modern and very original concern. The nature of the trade is such that the margin of profit cannot be heavy; and in the early period of such enterprises there is always a great and apparently wasteful outlay of money, thought, and labor in creating and improving. Our country is yet new. Vast as the existing

THE MODERN COUNTRY SCHOOL-HOUSE.

school mercantile interest already is, we have, in fact, barely entered the real school-organizing period. The business of the firm hitherto has partaken largely of a missionary character; has drawn heavily upon the faith of its managers and supporters. But the original projector of the house, as well as his partners in it, have not at all lost confidence in the importance of the school interest, and in the magnitude of the part which they must play in working out American destiny; nor, accordingly, have they any fear for the ultimate success of their undertaking in a business

point of view. It would be an unprecedented violation of the laws of business should such industry, perseverance, and fertility of contrivance remain permanently unrewarded.

Indeed, the business has already fully verified the predictions of its founder as to the main principles involved. It was believed that there was a national demand for such a central depot as this in the business metropolis of the nation; and the operations of the house have become national. It has become a regular resort for persons interested in education from all parts of the country, and its agencies are open in most of the principal cities of the Union. Its trade extends from Canada to the Mexican border, and from Maine to California. Orders from England are frequent; trade with South America is large; Honolulu, and other localities of the

SCHOOL FURNITURE.

islands of the sea, make frequent demands upon the facilities of the house; it has furnished the public schools of Melbourne, in Australia; and distant missionary stations, as they establish schools, are habitually resorting here for supplies.

No more vivid representation of the advance of educational improvements for the last quarter of a century could be made than is supplied by a contrast between the catalogue which Messrs. J. W. Schermerhorn & Co. publish of the school material for sale by them, and the condition of things twenty-five years ago. On one hand, a handsomely printed volume of a hundred and fifty pages, containing two hundred and forty-four elegantly executed wood-cuts, to begin with; and specifying the names and prices of several hundred books, describing dozens of different courses of study; cataloguing not merely the articles represented in the

illustrations, numerous as they are, but twenty times as many, with prices at retail and wholesale, suggestions for use, etc., etc., to the extent of being substantially a practical pictorial educational encyclopædia. So much for the list of to-day. As for that of twenty-five years back — there is none.

It is out of the question to give within the limits of an article like the present even an approach to a full summary of the materials thus catalogued and represented. But a list of the names of fifty of the items, picked out in turning over the pages, and which we throw into an alphabetical order, will surprise any one not

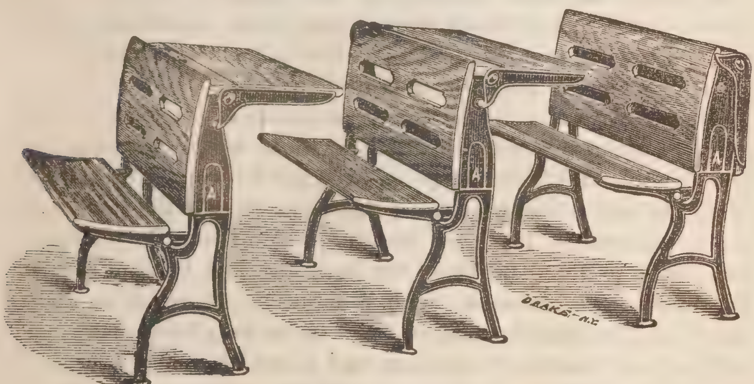
ROGERS'S GROUP — SCHOOL EXAMINATION.

thoroughly familiar with the subject, so varied are the articles, and so wide the range of knowledge illustrated, processes of study assisted, and devices contrived: —

Abacus, alphabet blocks, arithmetical solids, barometer, book carrier, color cube, crayon holder, croquet set, cube root blocks, dissected cone, dividers (for blackboard use), drawing paper, dumb bells, eraser, geometrical forms and solids, globe (slated), gonigraph, hat rack, hydrometer, Indian clubs, kindergarten blocks, letter clip, liquid blackboard, lunch box, magic lantern, magnet, mariner's compass, mathematical instruments, microscope, organ, orrery, pencil file, planisphere, prism, rain gauge, Rogers's school

groups, school bags, season machine, shoe scraper, slate rest, song roll, spelling stick, stream of time, sweeper, tape measure, tellurian, thermometer, wall slate, wands (for exercise), waste basket.

This list, it will be observed, omits such obvious items as chair, desk, ink, paper, etc. It is not unlikely that some of our readers may have to stop and think before they can tell what some of these things are for. What is a gonigraph? a pencil file? a season machine? a spelling stick? "Gony" is, or used to be, a slang term for "a silly fellow;" does a gonigraph describe gonies? Is the file to sharpen the pencil or to keep it? Can your season machine turn out weather to order? Will a stick spell? Even the man of to-day might almost be imagined to put these questions. But please to hear about Master Tileston and



THE ASSEMBLY ROOM DESKS AND SETTEES, WITH ALLEN'S OPERA FOLDING SEATS.

the pen-wiper, and then imagine what that excellent old gentleman would have said to Schermerhorn & Co.'s catalogue of school material. Master Tileston, who died not far from 1824, at the age of eighty-five or more, was writing-master in one of the Boston schools for over half a century. Sundry curious anecdotes are told about the good old gentleman; but that which is to the present point, and which was recorded by one of his pupils, is as follows: This pupil had become apprentice in a bookstore, when his old instructor entered the store: "Out of respect for the venerable man, the pupil wiped his pen on a rag that hung by the desk for that purpose, and suspended his work. The old gentleman approached the desk, and carefully raising the rag with his thumb and forefinger, said, 'What is this for?' 'To wipe the

pen on, sir, when we stop writing,' said the respectful pupil. 'Uh! it may be well enough,' said he, 'but Master Proctor had no such thing!' Master Tileston always *wiped out his pen with his little finger, and then cleaned his finger on the white hairs just under his wig.* His model, Master Proctor, had been dead half a century, perhaps, but he still lived in the routine that he had established."

The pen-wiper evidently was a sore burden to the poor old man. The gonigraph would have staggered him; the magic lantern would have been little better than sacrilege in his eyes; and the Indian clubs would have beaten his very life out. And yet this comprehensive and seemingly heterogeneous variety of school material corresponds to a very wise saying of a very judicious old gentleman of far more ancient date than Master Tileston — that famous and practical Greek, the Spartan King Agesilaus — who, on being asked, "What ought children to learn at school?" replied, "Whatever they will need to do as men."

Besides the extensive arsenal — so to speak — of educational ordnance and munitions of war wherewith to teach the young idea how to shoot, the house keeps on hand a full specimen assortment of all the best school books, and furnishes them in the same manner as apparatus, maps, or furniture. Moreover, it publishes, from time to time, books of its own, the last being Professor Johonnot's *School-Houses,* with designs by Hewes — an elaborate work, bringing its subject down to the very latest dates, and with a great number of drawings and plans for school-houses of all sorts, materials, and sizes. And lastly, it issues *The American Educational Monthly,* a lively periodical, which serves as a record of contemporary educational history, doctrine, and practice, and as a common organ of communication among those interested in schools and other institutions and instrumentalities of learning.

Such an institution as has thus been described could not exist except amidst a great number of highly improved and improving schools. It at once lives by them, and helps them live; and while it is justly entitled to large pecuniary success, it is at the same time incomparably most significant as an index and engine of mental and moral improvement.

CUTLERY.

THE DERIVATION OF THE WORD. — CUTTING TOOLS BEFORE THE IRON AGE. — AMONG THE EGYPTIANS. — THE HINDOOS. — THE TEST OF COMPARATIVE CIVILIZATION. — THE MANUFACTURE IN SHEFFIELD. — CHAUCER QUOTED. — THE INTRODUCTION OF FORKS INTO ENGLAND. — THE MANUFACTURE IN THE UNITED STATES. — THE INTRODUCTION OF IMPROVED METHODS. — DETAILED ACCOUNT OF THE NEW PROCESSES. — THE RESULTS OF MACHINE AND HAND LABOR COMPARED. — DESCRIPTION OF THE RUSSELL MANUFACTURING COMPANY'S WORKS. — THE AMOUNT OF THEIR YEARLY PRODUCTION.

Our term *cutlery* is derived, through the process of phonetic change which characterizes the passage of Latin to English, from the Latin word *culter*, meaning a small knife, as distinguished from a sword.

One of the earliest necessities of mankind must have been to shape some tool into a cutting edge. Before the discovery of the art of working metals was known, men used bone, or hard woods, or stone. The Egyptians had the art of tempering copper to a hard, cutting edge, and from them many of the nations of antiquity derived the process, which is now lost, and made their sharp implements of war, or for domestic usage, from this material.

The art of making steel was, however, known to the natives of India before the time of Alexander the Great, and from the steel there made the famous Damascus blades were tempered in the city of that name. Singularly enough, some of the uncivilized races, as those in Borneo, and others, have now great skill in tempering their weapons, though they use a rude method which has probably been handed down by tradition from a very early age.

One of the chief characteristics, however, of civilization, is that the industry and invention of the people who have arrived at such a condition of social advance, are chiefly devoted to the production of tools and utensils for domestic and industrial use, instead

of weapons for use in war. Judged by this standard we can compare the progress of our own times with that even of Greece and Rome, and without vanity we can congratulate ourselves upon the comparison. The Grecians and Romans forged and tempered swords, which performed their bloody work only too completely; but they still ate with their fingers, and the cleanly decency of knives and forks was unknown even to their kings, their statesmen, or their philosophers.

The steady growth of mankind towards that ideal future when the world shall be at peace, when mutual aid and sympathy shall replace national jealousies, and the relations of nations shall attain the plain of reason and law which now prevails between gentlemen, is shown by the fact that now the art of making cutting weapons is chiefly employed for pacific purposes, and our cutlery uses more steel to make our table knives which serve to increase our social culture, throwing the graces of good breeding about the occupations for the support of life, than in fashioning the weapons for war, by which men meet to only attempt their mutual destruction.

Up to within quite a recent date, the chief supply of cutlery for the civilized world was manufactured in England. At a very early period this art was practised there, and Sheffield, which is still the chief seat of the manufacture of knives, was celebrated for the same article as early as the times of Chaucer, the father of English poetical literature, who writes, —

"A Shelfeld thuytel bare he in his hose."

The word *thuytle* is the old form for *thwite*, a knife, which is itself now obsolete, but traces of which still remain in the language, in the diminutive *thwittle*, from which we have our word *whittle*.

Though knives were made in England at an early date, yet they were not a regular piece of table furniture, and the fingers were still the chief implements used for eating. In the time of James I., Coryatt, the traveller, in his account of his tour through Europe, mentions forks as recently introduced into Italy, and speaks of their use as a curious custom.

The manufacture of cutlery is of quite recent introduction into the United States, but has made such progress, owing to the improved methods and machinery introduced into the processes, that it will be best to mention only these, since thus the reader will

quicker and easier become acquainted with the latest and best modes for its manufacture.

The leading manufactory of cutlery in the United States is the Russell Manufacturing Company, at Greenfield, Massachusetts. The business was commenced by John Russell, of Greenfield, who was born in 1797. He is a man of a remarkable business capacity, with great decision and perfect integrity. In 1834, being engaged in the manufacture of edged tools, such as chisels, &c., he commenced, upon a small scale, that of table cutlery. This was the first attempt made to introduce this branch of industry into the United States. At first the attempt appeared to be a failure. The goods produced did not pay the cost of manufacture, the difficulty being the lack of skilled workmen. During this first year, however, the amount produced was very small. Mr. Russell, nevertheless, still persevered in the attempt, though he had to contend not only against the difficulties inherent in any new enterprise, but also against a foolish prejudice against American cutlery; so that, though he produced wares which were actually as good as those imported from Sheffield, yet they could not be sold as readily or as well.

At first the capital to carry on the business was small, and all the operations were performed by hand labor, the only machinery in use being the emery wheels and grindstones for grinding and finishing the blades; the handles, or hafts, being made entirely by hand, and the blades forged by the same tedious and expensive method.

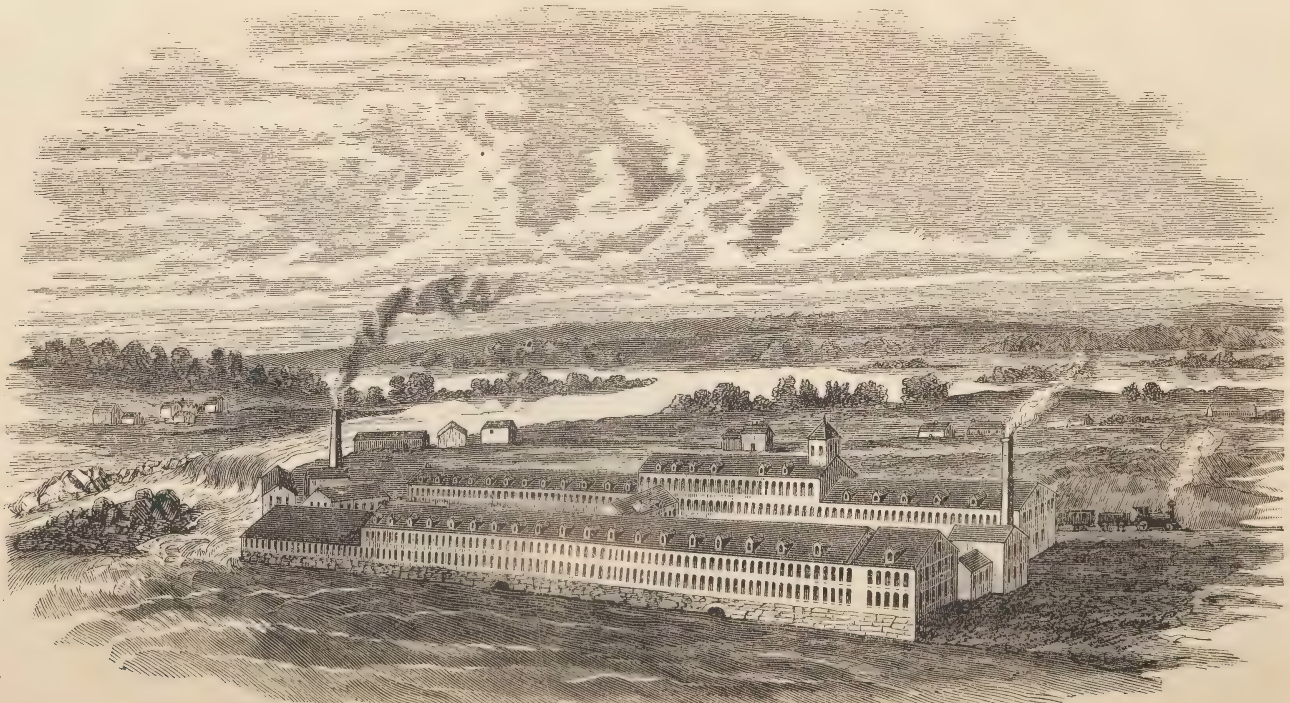
At this time the market was entirely under the control of the Sheffield manufacturers, who, though they used, and still in a great measure use, more hand than machine labor, yet having the advantages of an established business, a reputation, and a buying public prejudiced in their favor, could force out any competition from American manufactories. The first improvement made by Mr. Russell, in the processes used in the "Green River Works," was the introduction of the trip hammer for forging the blades. This improvement is purely American. Though trip hammers were then in use in England, in forging large masses of metal, yet the idea had never occurred to any one to use them for this purpose. At first in the "Green River Works," two trip hammers were introduced. This improved process did much towards cheapening the manufacture, and together with the next introduced, by which the *bolsters*, or that part of the blade which

abuts upon the handle, and *bolsters* it, or supports it, were also struck up by the trip hammer instead of by hand, enabled the American production to compete successfully with the Sheffield manufacture.

This process of forming the bolster is called *swedging*, and the importance of the introduction of this process, as an improvement over the old-fashioned way of forming them by hand, is shown by the following fact: By the hand process, a man, aided by a striker, who swung the hammer, could, in a day, subject about one hundred and fifty blades to this process, while a trip hammer, with one man and a tender, can accomplish the same for about three thousand blades. But the improved processes were not allowed to stop here, and the next step was the introduction of machinery to perform the plating, or shaping, of the blade, and the cutting of the same into the required shape by dies, which were crushed in a cam power press. These two improvements were of great importance, since they replaced by one, and the same operation, the tedious and slow methods of plating the blades; that is, of making a blade from a plate of steel by hammering it into shape, and then cutting it out.

By these improvements the manufacture of the entire blade, with its bolster, was transferred from hand work to machinery, with the increase of production, and cheapening of expense, consequent upon such a transfer. The next improvement was directed towards the process of preparing the handles. For wooden handles, the wood from the apple tree is preferred. The improvement in making them consisted in subjecting them, hot with oil, to a pressure in a machine. In this way the handles are greatly improved, and oak, maple, and other woods can be used. The next improvement was the invention of an ingenious way of making the bolster, so that it should hold the *scales*, or the slips of wood, or other material, forming the handle, to the *tang*, or the projecting prong to which the outside of the handle is riveted. This improvement was invented by Matthew Chapman, and patented by the company as assignee in 1862.

This patent bolster does away with the necessity for forging or swedging the bolsters, and so simplifies the process of manufacture as to quadruple the production. The next improvement consisted of making the blade, the bolster, and the handle all of steel, forged from one solid piece. This process, like the two previously mentioned, was also invented by Mr. Chapman, and the patent



JOHN RUSSELL MANUFACTURING COMPANY; GREEN RIVER WORKS, MASS.

steel-handled knife, which is made by this process, has already entered largely into consumption. The handles are silver-plated, and the knives are quite elegant in appearance, and convenient to use, especially in hotels, for which they are specially adapted.

A still further improvement has been made, by which the blade is manufactured of steel, and the handle of iron, which is afterwards japanned, and thus affords a cheaper article. All of these later improvements are patented, thus giving the control of their use to the company. Besides this the company control in this country the use of *ivoride*, a patented article made in England, and which can be distinguished from ivory only by a skilled expert.

Though, as has been shown in the above remarks, the various processes of making cutlery have been so successfully simplified and cheapened by substituting for the slow and tedious methods of hand labor the more rapid and accurate work of machines, yet the process of making knives is still quite a complicated one, and one which requires the coöperation of a great many men. From the selection of the steel to be worked up, which requires skilled experience and judgment, through all the various processes of manufacture, up to the point when the manufactured articles are ready to be offered for sale, constant care and attention are necessary to insure the excellence which has been recognized by the public.

Most of the improved processes of manufacture, which have been alluded to, are also applied by the Russell Manufacturing Company in their manufacture of forks. The prongs of these are cut and shaped by machinery, and the entire fork, handle and all, are made by the same process by which the solid knives are made.

Though the improved machinery has increased the production, while it has simplified the methods, yet still the processes through which a knife has to pass before being ready for sale, are many and various, as may be seen from this list: First, cutting steel into proper lengths; second, trying blade under trip hammer, and bolstering; third, shaping under a press; fourth, straightening; fifth, ground for the stamp; sixth, stamped; seventh, hardened; eighth, tempered; ninth, ground; tenth, hafted; eleventh, finished on the emery wheels, and the handles so finished; twelfth, bolsters so finished; thirteenth, buffed; fourteenth, cleaned; fifteenth, inspected; sixteenth, packed.

Numerous as these operations may seem, yet, in fact, they are

much fewer than by the old process. A penknife, by the old method, is said to pass through a hundred hands before it is ready for sale.

To give an idea of the vast variety of goods manufactured by this company, it may be stated that they make thirty different styles in each class of the following table cutlery, with the finest ivory, pearl and ivory (2d class) handles of different patterns — oval, fluted, square, octagon, oval ornamented, grooved, "tulip," shell head, with fancy carving, with and without silver ferrules, etc., etc. — viz.: table knives, dessert knives, meat or game carvers, Jones' carvers, steels and concave steels ; eleven patterns of butter knives, with ivory, fine ivory, pearl, cocoa, ebony and horn, square, oval, and octagon handles ; two kinds of cheese scoops, steel and silver plated, with ivory and ivoride handles ; four varieties of fruit knives ; four kinds of nut-picks ; twenty-two kinds of knives and forks with cocoa handles ; two kinds with iron handles ; four kinds with horn handles ; twenty-two kinds with ebony handles ; fifteen kinds with bone handles ; and each kind with dessert sets, carvers, steels, etc., to match.

The ivoride, to which we have referred, and which presents a scarcely distinguishable substitute for ivory, gives superior handles, which will not break or crack, nor absorb grease and stains. They are put on without cement, so that they are not injured by contact with hot water, and are warranted to hold fast as long as they are in use. Besides the solid steel, silver-plated handles, manufactured expressly for hotels, restaurants, steamboats, and other hard service, the company make wrought oval hollow-handled plated knives and forks, and hollow metal handle silver-plated table and dessert knives. All these goods are made, not merely to sell, or to be admired as beautiful and artistic specimens of work, but are designed for *use*, and consequently every detail receives the greatest care and attention, so that the well-merited reputation of the company may be maintained.

This company turns out a great variety of very superior pocket knives, of different sizes and patterns, with ivory, horn, bone, cocoa, ebony, and imitation stag handles, at prices ranging from four to ten dollars per dozen. They heavily silver-plate all table cutlery so ordered. They also manufacture rose-wood cases, of different sizes, for fine table cutlery, and make to order rosewood and morocco cases for any number of pieces.

To show how much raw material is required in such an estab-

lishment, we give the following figures for a single year: 2,000 tons of anthracite coal; 25,000 bushels of charcoal; 400,000 pounds of grindstones; 44,000 pounds of emery; 3,000 pounds of beeswax; for handles, 36,000 pounds of ivory, 112,000 pounds of ebony, 57,000 pounds of rosewood, 305,000 pounds of cocoa-wood. Every day two tons of steel are used. A large amount of silver is used in plating blades and handles. The increase of business from year to year compels a proportionate increase of this enormous quantity of raw material of the different kinds.

Besides their various styles of table cutlery, the company manufacture California hunting knives, butcher knives, bread knives, beef slicers, carving knives and forks, of which a knife specially designed for the carving of fowls should be mentioned. This knife has the blade made narrow, so as to be more easily moved about in search of the joints.

In the gradual social advance of mankind, industrial pursuits offer one of the best fields for displaying the increased power gained by organization, and the advantage of applying scientific knowledge to the processes in use. One of the best examples of the truth of these axioms is afforded by the Russell Manufacturing Company. An ignorant adherence to the traditional methods in use would have resulted in failure, and have simply intensified the opinion that the manufacture of cutlery could not be successfully established in the United States. But in industry, as in science itself, or in any other department of human interest, the new spirit of investigation, which takes nothing for granted, but, wisely sceptical concerning all authority, seeks to discover new methods and new appliances in harmony with the new conditions of the social organization, is the only spirit with which our industry must be carried on in order that it should advance in line with our moral and social progress.

The works of the Russell Manufacturing Company are at Turner's Falls, Mass. The power used in the manufactory is water power derived from the Connecticut River, and the amount used by the company is estimated as equal to seven hundred horses. The buildings of the company are arranged in the form of a parallelogram, enclosing a middle building and a yard. The two larger buildings are each six hundred feet long by fifty wide, rising four stories on the inner and two stories on the outer side. The stories are high and commodious, measuring fourteen feet from floor to ceiling. The interior building is three hundred feet

long by forty wide, and is only one story high, being devoted to the various smith shops of the company.

The ventilation of the buildings is admirable, and in the grinding rooms, where, from the immense business they are required to do, the dust would be oppressive and injurious to health, it is all carried off by a system of fans and channels, so that the air is kept perfectly free from it.

The company own also a branch railroad, three-quarters of a mile long, connecting with the Vermont and Massachusetts Railroad. From the average steady increase of their sales during the past, their sales for this year (1871) will probably reach one million and a half of dollars. The company disburse an average of over twenty-five thousand dollars a month to their employees; and as the means for doing this are derived from the sale of their manufactured products all over this country, from Maine to the Pacific, it offers a practical proof of how important an agency the industry of the country is in demonstrating the necessity and value of unity and peace, thus arriving by practice at the same results which by theory the moralist and the scientist have before proclaimed.

CIGARS AND MANUFACTURED TOBACCO.

DERIVATION OF THE WORD "CIGAR." — OF "TOBACCO." — THE INTRODUCTION OF ITS USE. — KING JAMES'S "COUNTERBLAST." — BURTON'S COMMENTS ON THE HABIT. — THE CALUMET. — TOBACCO IN CHINA. — CHINESE SNUFF AND SNUFF-BOXES. — CIGARS IN VARIOUS COUNTRIES. — THE CIGAR MANUFACTORIES OF THE UNITED STATES. — THE PROCESS. — BYRON ON TOBACCO. — THE CULTIVATION OF THE PLANT. — THE VALUE OF WIVES IN TOBACCO. — THE EXTENT OF THE TOBACCO TRADE. — THE SCIENTIFIC EXAMINATION OF THE EFFECTS OF TOBACCO.

THE Cigar is supposed to be of Spanish origin, and is called *Cigarro* in Spain. It is a small roll of tobacco, so formed as to be tubular, and is used for smoking. *Cigarrito* is a smaller roll of finely-cut tobacco wrapped in unsized paper.

Tobacco was the name used by the Caribbees for the *pipe* in which the natives of the islands smoked a certain weed, which name the Spaniards transferred to the herb itself. It was by them introduced into Spain and Portugal. The botanical name of the various species of the plant is *Nicotiana;* so called after *Jean Nicot,* of Nismes, in Languedoc, who was an agent of the King of France in Portugal, where he procured the seeds of the tobacco from a Dutchman, who had procured them from Florida. Nicot sent them to France in the year 1560.

This plant appears to be a native of the West Indies, and of different parts of America. The common Virginia tobacco is largely cultivated in the United States and in Europe. Another species is called Orinoco Tobacco, and is larger than the Virginia plant, the stem rising from five to seven feet high; the milder Havana cigars are said to be made of it. Another kind is called English Tobacco, because it was the first species introduced into that country from America. It grows on the coast of the Mediterranean, and thence finds it way into India. The difference of climate and

soil in which this plant is cultivated imparts to it different qualities. In the shops this tobacco is known as Turkish.

The general form in which tobacco is used is for smoking. This, too, is the most ancient mode of using it. As smoking has now become a general, and, apparently, an indispensable luxury, the cultivation and consumption of tobacco has increased in greater proportion than almost any other product of agriculture. And were it not for the fiscal restrictions arising from duties imposed by many governments, its cultivation would doubtless be much more increased, and be a great resource to native industry in all countries where the plant could be made to grow.

The discoverers of America introduced the habit of smoking into Spain and Portugal, from whence it was adopted in other parts of the continent. The persons who composed the colony which Sir Walter Raleigh sent to Virginia returned unsuccessful in 1586, and introduced the habit into England. The historian of that expedition, Hariot, carefully observed the culture of tobacco, and by using it, became a firm believer in its medicinal and healing virtues. And Raleigh himself is said to have written of its excellences, as

> "Rest to the weary, to the hungry, food,
> The last kind refuge of the wise and good."

Before the establishment of the Virginia Colony in the year 1606, the tobacco imported into England came through the Spaniards, from the West India Islands. Its use in England encountered great opposition, especially from King James, who stigmatized it as a "precious stink." In the year 1604, without the consent of Parliament, the king raised the duty on tobacco from two pence, to six shillings and ten pence a pound. In the communication addressed on this occasion to the Lord Treasurer, he said that, "Tobacco being a drug of late years found out, and brought from foreign parts in small quantities, was taken and used by the better sort, both then and now, only as physic, to preserve health; but that persons of mean condition now consumed their wages and time in smoking tobacco, to their great injury, and to the general corruption." Its cultivation was forbidden in England, and the plants then growing were ordered to be rooted up. Not long after the "Counterblast to Tobacco" by King James, the quaint Burton, who could write of "Borage and Hellebor," as

> "Sovereign plants to purge the veins
> Of melancholy,"

mingled praise and condemnation in speaking of that herb: "Tobacco, divine, rare, super-excellent tobacco, which goes far beyond all their panaceas, potable gold, and philosophers' stones, a sovereign remedy to all diseases. A good vomit, I confess, a virtuous herb, if it be well qualified, opportunely taken, and medicinally used; but as it is commonly abused by most men, which take it as tinkers do ale, 'tis a plague, a mischief, a violent purger of goods, lands, health, hellish, devilish, and damned tobacco, the ruin and overthrow of body and soul." (Burton's Anat., p. 444)

But all condemnation of the weed appeared only to bring it into higher favor and more general use. Columbus found the natives of Hispaniola smoking a plant, "the perfume of which was fragrant and grateful," which from earliest ages had been offered as incense to their imaginary gods. The early colonists to Virginia found that pipes and tobacco held a most important place in all transactions among the Indians. The Calumet, or Pipe of Peace, was made of red, black, or white stone, finely polished. The stem was about two and a half feet long, made of strong reed or cane, adorned with feathers of all colors, interlaid with women's hair. Two wings of some rare bird were fastened to it, so that the Calumet somewhat resembled the wand of Mercury. The pipe was a safe-conduct among the allies of the tribe which gave it, and in all embassies, the ambassador carried it as a symbol of peace. They believed a great misfortune would befall them if they violated the public faith of the Calumet. All their enterprises, declarations of war, or conclusions of peace, as well as all other ceremonies, were confirmed with the Calumet. They filled the pipe with the choicest tobacco, and presented it to those with whom they concluded any important affair, and then smoked the same after them.

A recent traveller through the Chinese Empire says the cultivation of tobacco is immense, though the plant was not known in China till a very late period. It is said to have been imported into the Central Empire by the Mantchous; and the Chinese were much astonished when they first saw their conquerors inhaling fire through long tubes and "eating smoke." It was at first difficult for them to imitate this accomplishment, but now they are passionately devoted to it. By a curious coincidence, this plant is called, in the Mantchou language, *tambakou*; but the Chinese designate it simply by the word meaning *smoke*. Thus they say they culti-

vate in their fields the "smoke leaf;" they call their pipe the "smoke funnel."

The use of tobacco has become universal throughout the empire; men, women, and children, everybody smokes, almost without ceasing. They go about their daily business, cultivate the fields, ride on horseback, and write, with the pipe always in their mouth. During their meals, if they stop for a moment, it is to smoke a pipe; and if they awake in the night, they are sure to amuse themselves in the same way. It may be easily supposed, therefore, that in a country containing 300,000,000 of smokers, without including the tribes of Thibet and Tartary, who lay in their stocks in the Chinese markets, the culture of tobacco has become very important. The cultivation and sale are entirely free, without any interference of government.

"Snuff-takers are less numerous in China than smokers; tobacco in powder, or, as the Chinese say, 'smoke for the nose,' is little used except by the Mantchou Tartars and Mongols, and among the mandarins and lettered classes. The Tartars are real amateurs, and snuff is with them an object of the most important consideration. The custom of taking snuff was introduced into China by the old missionaries (French), who resided at the court. They used to get the snuff from Europe for themselves, and some of the mandarins tried it, and found it good. By degrees the custom spread; people who wished to appear fashionable, liked to be seen taking this 'smoke for the nose.' Pekin is the special locality of snuff-takers. The first dealers in it made great fortunes. The French tobacco was the most esteemed; and as it happened at this time that it had for a stamp the ancient emblem of the three *fleurs de lis*, the mark has never been forgotten; and the three *fleurs de lis* are still, in Pekin, the only sign of a dealer in tobacco. The Chinese have now for a long time manufactured their own snuff; but they do not subject it to any fermentation, and it is not worth much. They merely pulverize the leaves, sift the powder till it is as fine as flour, and afterwards perfume it with flowers and essences. Their snuff-boxes are little vials made of crystal, porcelain, or precious stones. They are sometimes very elegant in their form, and are cut with great taste, and sold at immense prices. A little silver or ivory spatula, with which the pinch is taken out, is fitted to the stopper."

The manufacture of cigars, and the preparation of tobacco in other forms for smoking, is a most important industry in all coun-

tries where that herb is cultivated. The best tobacco for cigars, holding the highest rank for the excellency of its flavor, is grown on the island of Cuba, from whence innumerable cigars are exported to all parts of the world. The cigars known as cheroots have a good reputation; they are made in Manila, and exported in large quantities. Mexico produces a large amount of tobacco, but entirely for home consumption, of which the greater part is used for smoking. Cigars are made in Spain, and most other countries of Europe, in great numbers; the city of Bremen alone employing more than four thousand persons in making them, and exporting 300,000,000 annually. In France, tobacco is grown in larger quantities than any other vegetable, except wheat, owing to the extensive consumption of cigars and snuff among all classes of society. A kind of cigar is made in Switzerland, of a poor quality of tobacco, which, by some process (known only to the manufacturers), is greatly improved, and a very good cigar can be sold at retail for one cent. Count Cavour persuaded one of the Swiss manufacturers to go to Turin, and superintend the making of cigars by the same secret process. These cigars are known in Italy as "Cavours," and are sold for one cent each.

In 1860 there were in the United States fourteen hundred and seventy-eight establishments for the manufacture of cigars, using more than three millions of capital, and three and a half millions in value of raw material. There were employed in these establishments seven thousand two hundred and sixty-six males, and seven hundred and thirty-one females, at a cost for labor of $2,531,354. The total value of cigars from these manufactories in 1860, was $9,068,778.

The process of making cigars is simple and easy. A sound piece of leaf, shaped like one of the gores of a globe, is placed on the work-bench. A bundle of fragments of leaves is placed across the centre of this gore, and rolled up in it by passing the hand flat over it. The point of the cigar is shaped with a pair of scissors, and secured by means of a solution of gum and chiccory. The cigar is next placed against a gauge, and a portion from the broad end cut off square. This is the French mode of manufacture, and is the work of women altogether; and in all foreign countries, female labor is chiefly employed in cigar-making.

The large amount of capital employed in the cultivation and manufacture of tobacco, and the untold millions of pounds consumed in smoke in all parts of the world, would seem to indicate

that it is profitable to the producer, and a source of pleasure and comfort to those who smoke it. Though its use has been condemned as unhealthy and even immoral, the world generally *puffs* at these censures. Lord Bacon wrote: "Tobacco comforteth the spirits and dischargeth weariness, which it worketh partly by opening, but chiefly by the opiate virtue which condenseth the spirits." The eminent English divine, Dr. Barrow, excused his great fondness of tobacco by saying, "It did very much regulate his thinking." In reference to the universality of its use, Lord Byron speaks of the "short, frail pipe" which "puffed where'er winds rise or waters roll," and "wafted smoke from Portsmouth to the pole."

> "Sublime Tobacco! which from east to west
> Cheers the tar's labor or the Turkman's rest;
> Which on the Moslem's ottoman divides
> His hours, and rivals opium and his brides;
> Magnificent in Stamboul, but less grand,
> Though not less loved, in Wapping or the Strand;
> Divine in hookas, glorious in a pipe,
> When tipped with amber, mellow, rich, and ripe;
> Like other charmers, wooing the caress
> More dazzlingly when daring in full dress;
> Yet thy true lovers more admire by far
> Thy naked beauties — give me a cigar!"
>
> *The Island*, pt. xix.

For exportation, tobacco is most extensively cultivated in the United States. A very large proportion of that which is consumed in Europe is grown in this country. The mode of cultivation is substantially the same in all countries. The seed is sown in prepared seed-beds in March, or early in April, and carefully protected from the frost. When the plants are two or three inches out of the ground, they are ready for transplanting. The field must be well prepared, and from only good, rich land can a satisfactory crop be secured. The plants must be carefully cultivated, kept free from weeds and dead leaves, and the soil frequently stirred about the roots. When the plants are about two feet high, the leading stem is clipped so as to prevent it from running to flower and seed. After the topping, from five to nine leaves are left on the stem, the fewer the number the stronger will be the tobacco. When fully ripe the leaves change their appearance, and become in color a yellowish green. The plants should be cut when ripe; if cut before, the leaves will not have a good color in curing, and when packed will be likely to rot. The plants are cut

near the ground, and after a few hours' exposure to the sun, are removed to the place of curing, which should be properly ventilated, where the stalks are suspended on poles. In four or five weeks the tobacco is ready to be put up for market. A damp or rainy day is selected for taking down the stalks and stripping off the leaves. A number of leaves are tied together at their thickest end; each bundle of leaves is called a *hand*. These bunches of tobacco are then heaped together, when they undergo the process of sweating. When thoroughly cured it is packed in hogsheads or boxes for shipment.

It was in the year 1615 that the colonists of Virginia abandoned all other employments, and devoted themselves to the culture of tobacco. "The fields, the gardens, the public squares, and even the streets of Jamestown, were planted with tobacco. As tobacco gave animation to Virginian industry, it eventually became, not only the staple, but the currency of the colony." (Bancroft's Hist., Vol. I., p. 151.) In 1619, "ninety agreeable persons, young and incorrupt," and in 1621, "sixty more maids, of virtuous education, young and handsome," were sent out from London, on a marriage speculation. The first lot of females was bought by the colonists for one hundred and twenty pounds of tobacco each; but the second lot brought one hundred and fifty pounds each. This certainly might be called a virtuous use of the weed.

From the earliest settlement of Virginia, therefore, tobacco has been a most important article in the agricultural and commercial interests of the country. The tobacco crop for the year 1869 was estimated at 273,775,000 pounds, at a valuation of $32,206,325. In 1870 there was exported from this country 185,748,881 pounds of leaf, besides 365,000 cigars, and 20,181 pounds of snuff, and other manufactured tobacco, to the total value of $22,705,225. The importation of manufactured tobacco has greatly decreased since the imposition of high duties. In the year 1857, the value of cigars imported into the United States was $4,221,096, while in 1870 the cigars imported were valued at only $1,621,609.

Great Britain, and all British possessions, received from the United States in the year 1870, 54,433,695 pounds of tobacco, 84,000 cigars, and 12,670 pounds of snuff. The city of Bremen received 41,977,412 pounds of tobacco; Italy received 27,629,871 pounds; France received 23,387,339 pounds. The net yearly income received by England from duties on tobacco is about $23,000,000.

The demand for tobacco, as a medicinal herb, must be very limited; as a luxury, the demands are enormous. Millions of acres and millions of men are devoted to its cultivation and manufacture. The commercial intercourse created by the demand for it employs a vast amount of tonnage for its importation and exportation. The home trade in the countries where it is used requires the attention of millions of men. In the year 1840 the number of dealers in Great Britain was 185,755. If, in other countries, there is the same proportion of dealers to population, the number so occupied cannot be less than 7,000,000. The amount of vital force expended by all nations and peoples in "inhaling fire through long tubes" and "eating smoke," cannot be estimated. Its visible result, however, is only smoke.

In modern times, however, the school of scientific students, who aim to arrive at their conclusions rather by a study of facts than from an appeal to their own prejudices or fancies, have turned their attention to the facts of the consumption of tobacco. When it is remembered that at present there are many millions of human beings in the habit of daily using tobacco, and that its use has spread with wonderful rapidity among both civilized and uncivilized nations, it will appear as though there was some good and sufficient reason for such a change in the manner of our living. Besides, too, chemistry has shown that the essential principle of tobacco and of tea and coffee is the same, and that the use of all these stimulants, which were introduced to the world about the same time, has an effect in stimulating the nervous energy of those who use them. Mr. Johnson, whose contributions to a scientific knowledge of what we eat and drink are so well known, remarks that the old lady who spends for her tea the money which she seems hardly able to spare from her supply of food, is really doing wisely, instead of foolishly, since the money so spent is wisely spent. Her tea affords her the nervous stimulant she needs. In the study of modern society, no accurate estimate can be made of the causes of the nervous energy of modern times, without paying attention to the use of the modern stimulants, tea, coffee, and tobacco, the introduction of which is contemporaneous with the advent of the new spirit of energy which has revolutionized all our modes of thought, and which, in every department of human energy, has made so wide a distinction between the new and the old life of mankind; and a literature upon this subject is already commenced, in which it is studied, not metaphysically, but scientifically.

CONFECTIONERY, HONEST AND DISHONEST.

TEST FOR TERRA ALBA ADULTERATION OF CANDY. — NATURE OF TERRA ALBA. — GLUCOSE USED INSTEAD OF GUM ARABIC. — COMPOST IN IMITATION OF LICORICE. — OTHER ADULTERATIONS. — POISONOUS FLAVORS AND COLORS. — GOVERNMENT INFLUENCE IN AID OF ADULTERATIONS. — NATURAL FONDNESS FOR SUGAR. — FIRST HISTORICAL ACCOUNT OF SUGAR. — COURSE OF THE SUGAR AND CANDY BUSINESS. — NUMBER OF CONFECTIONERY HOUSES IN THE UNITED STATES. — RIDLEY AND CO. THE SENIOR HOUSE ON THE WESTERN CONTINENT. — THEIR RULES OF DEALING. — NO SUBSTITUTED OR INFERIOR ARTICLES. — NO LIQUOR NOR GAMBLING CANDY. — ACCOUNT OF MATERIALS FOR CONFECTIONERY. — PROCESSES OF MANUFACTURE. — SUGAR-BOILING SCALE. — TORPEDOES AND MOTTOES. — MOTTO POETRY. — EXTENT OF RIDLEY AND CO.'S BUSINESS. — QUEEN VICTORIA AND HOARHOUND CANDY. — SWINDLING IN THE CANDY BUSINESS UNNECESSARY.

Take some lozenges, or some "stick candy," or some "sugar-plums," say a wine-glassful or thereabouts, pound or break them up, if you choose, into small fragments, put these into a tea-cup or a two-ounce vial, and fill up with hot water; stir, or let it stand, until the candy is dissolved. If it was pure, it has disappeared, just as loaf sugar would do, except that, if it was colored, the coloring matter might slightly cloud the water. But in a good many cases a fine white or brownish powder will quietly settle to the bottom of the solution in a layer perhaps an eighth, or even a third, of an inch deep. This is *dirt;* at least it is a mineral. It is known in the wholesale candy and grocery business as *terra alba,* and it is manufactured in great quantities, and sold to swindle with, and for no other purpose. Sometimes wheat flour or starch is mixed with it, when the sediment is probably brownish.

This *terra alba* is nothing but plaster of Paris, or gypsum, chemically a sulphate of lime, which is composed of oxygen, sulphur, and lime, ground to a fine flour. Now, gypsum is useful to fertilize land, and to make cornices, and "hard finish" for walls

and ceilings. But the human stomach has not been found to require mineral fertilizers, nor do its walls receive benefit from being "hard finished." Gypsum, as an article of food, is just as good as slate-pencils, or hard coal. As coal dust would show, it is impracticable to cheat by mixing it with sugar; but as plaster is white, and does not show, the cheat is easy.

It is fortunate that this ground plaster of Paris can be used in confectionery without being burned in a kiln. It is this process of burning which makes it "set," as it is called. If candy were made with burned plaster, it would "set" in the stomach and bowels, furnishing a cast of our interior at the expense of our life. As it is, it only causes disorders of the stomach and bowels.

Sometimes half the substance of candy, or even more, is made up of this mineral. As it costs many times less than sugar, it is easy to see that candy made of it might be sold at a less price than unworked white sugar itself; and this apparent paradox has often been seen in our markets.

Numerous other tests, besides the very simple one above described of solution in water, would be necessary, most of them more scientific and difficult than this, before all the cheats which are common in the candy business could be found out. For instance, instead of gum arabic, of which considerable quantities are required, glucose is used. This is harmless, being simply a mucilage of dextrine, which is itself a modification of starch. But the cheat is, that glucose costs only eight or ten cents a pound, while gum arabic, of equal cleanness, costs sixty-five or seventy cents, and the price is not reduced in proportion. However, a practice has grown up among the candy-makers which may be called semi-honest. It is this: they mark the glucose gum-drops "A B," and they are known in the trade as "A B gum-drops," or "Arabian gum." This enables the retailer to know what he is about; so that this half of the matter is honest enough. But the consumer has not the same information; so that the retailer is tempted to charge a gum-arabic price for glucose goods. This might very justly be called, to use a rather slangy expression, a "*gum* game." These glucose gum drops, by the way, can be recognized by their peculiar "short" or brittle fracture, whereas the gum arabic has much more elasticity.

Again: a great proportion of what are sold as "licorice drops" are manufactured, *not* from the proper materials,—refined sugar, gum arabic, and licorice,—but from lampblack, glue, and brown

sugar, with as little licorice as will give this compost something like a proper flavor. In like manner the Tonka or Tonquin bean is very commonly used instead of vanilla. The same ground plaster of Paris, or terra alba, which is used in sugar, is extensively mixed with chocolate for the same purpose; tartaric acid and sulphuric acid are used instead of lemon for acidulating; etc., etc.

Instead of cochineal, which is harmless, but expensive, aniline, a poisonous product of coal tar, is extensively used to color red candies; and instead of saffron for the yellow candies, gamboge and chrome yellow, both poisons, are used. Indigo is comparatively harmless for blues, and "sap green," or vegetable yellows of other kinds, along with indigo, is safe enough for greens; but smalt, ultramarine, verdigris, Brunswick green, and other mineral poisons, are extensively employed.

Flavoring matters of a poisonous nature are as readily used in the ordinary confectionery of the shops as poisonous colors, or cheap dirt, and for the same reason, to wit, that more money can be made by poisoning people than by furnishing them healthful viands. An enormous quantity of the oil of turpentine is mixed with the peppermint oil, the oil of lemon, and the oil of cinnamon, which are used in flavoring candy, sometimes, indeed, to such an extent that the turpentine can be distinctly tasted. But far worse poisons than turpentine are used. All the "bitter almond" flavor that is given to confectionery, of whatever kind, is produced by prussic acid, one of the quickest and strongest poisons known to chemistry. Another class of poison flavors, common a few years ago, has fortunately gone pretty much out of use. This is not because the confectioners hesitated to sell the poison, by any means, but because its effects were so distinct that the public, careless as it is about its stomach, would not buy it. These flavors were used in what were called "banana drops," "pear drops," "peach drops," "pineapple drops," etc. Now the flavor of the pineapple drops was made from an extract of rotten cheese and sulphuric acid, and the others from a mixture in which a chief ingredient was the very poisonous "fusel oil," a well-known constituent of bad liquor, and equally well known to physicians as a powerful cause of the fatal and agonizing disorder of the kidneys, known as "Bright's disease." It is a fact that numbers of deaths of young children have been directly traceable to the use of some of these poisonous candies.

The temptations to perpetrate these (literally) sickening imposi-

tions are, no doubt, great, for the gain in money is great. So is the money gain of robbing a bank, or robbing and murdering a man. The yellow coloring matter obtained from saffron costs *thirty-five dollars* a pound, while chrome yellow costs *ten cents* a pound. Terra alba costs a little more than ordinary loam, while refined sugar costs eighteen or twenty cents a pound, or more ; and so on of the other poisons, as compared with nutritious or harmless materials. But more than this, it is a curious fact that the influence of the United States government has once, at least, been thrown directly in favor of the dishonest candy manufacture, as against the honest trade. During the war, the price of sugar was for a time as high as from twenty-eight to thirty-two cents a pound. Yet at that very time abundance of candy was in the market at seventeen or eighteen cents a pound — a state of things which only plaster of Paris can account for. However, the United States offered a further premium of two cents on every pound of dishonest candy, by means of a tax of four cents on all candy costing over twenty cents a pound, but of only two cents on such as cost less. But it is evident that no honest candy could have cost so little as twenty cents a pound ; so that the honest dealer had not only to compete with a cheating commodity offered at one half the price of his own goods, but with a further bribe of two cents allowed by his own government for every cheating pound over and above the advantage of the cheat itself.

It will be seen, however, by the account which a subsequent portion of this chapter will give of the business of the senior American house engaged in the candy manufacture, that one concern, at least, has found it possible to live, and to prosper, too, without the use of lying, swindling, poisoning, or dirt, during a business career of three quarters of a century.

The love of sweet things is as natural and healthy as any other appetite. Sugar and sugar candy are as good to eat as puddings or preserves, or anything else whose flavor is one of its recommendations. Very true, it is not suitable for sustaining life, if eaten without anything else during considerable periods, but neither is any one of the "proximate principles" which constitute food. We should sicken or starve on starch alone, or gluten alone, or fat alone, or albumen alone, or sugar alone ; but each of them is healthful in its place, as part of a properly arranged diet. It is said, indeed, that sugar is a prompt and fatal poison to frogs, and lizards, and to doves. So is salt to hens. But human beings are

neither frog, lizard, dove, nor hen, — whatever Mr. Darwin may believe as to their having been such a hundred million years ago, — and sugar and salt are good for the food of man.

Candy, like everything else, has a history, although it does not, within the records of Christendom at least, date very far back.

Before the use of sugar, honey was the great sweetener of culinary and confectionery labor, as the classic recipes sufficiently show. No other article is mentioned as so used in the Bible, which refers to honey as an article of food, or as an ideal of sweetness, some fifty times.

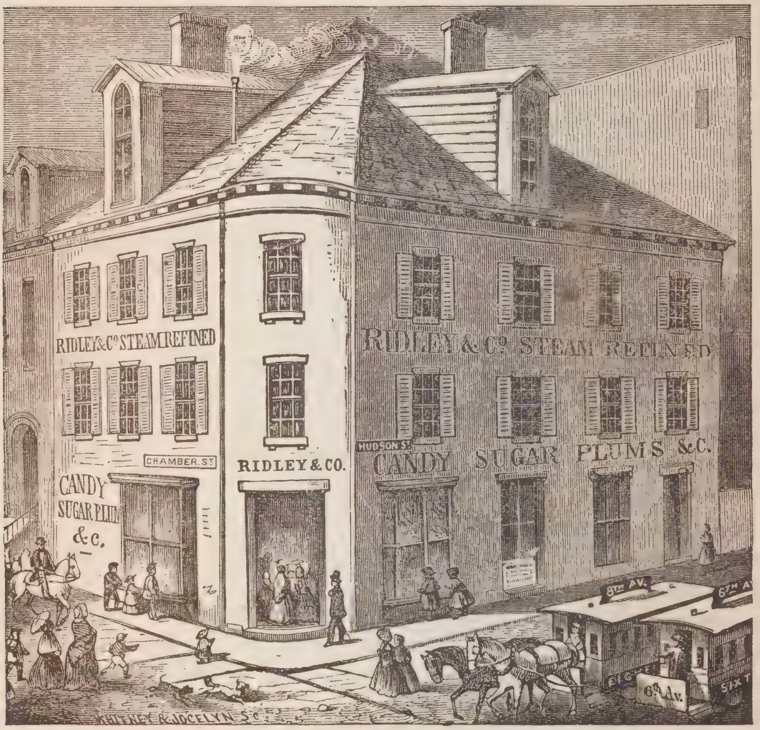
The sugar-cane, sugar, candy, molasses, and, for all we know, gingerbread and molasses candy, appear to have been known, however, from time immemorial among the Chinese. The sugar-cane, but not sugar itself, is supposed to be referred to by Greek and Roman writers on botany and medicine. The cultivation of the cane, the manufacture of sugar, and that of rock-candy also, — this being the earliest known of all the varieties of candy, — were brought by the Saracens from Asia into Cyprus and Sicily about the eighth century, and into Spain not far from the same time. About 1240 these industries were introduced into the Madeira Islands. In 1493, the very next year after Columbus discovered America, they were established in San Domingo, whence they spread to the other islands, and to the main land of America. Humboldt, after thorough research, became convinced that the sugar-cane was not known in America until thus introduced. It was not until 1563 that Admiral Hawkins brought sugar into England.

There are in the United States several hundred concerns engaged in manufacturing confectionery, and twenty-five or thirty in New York city alone. Much the oldest of them all, however, and indeed the senior concern of all on the Western Continent, is the house of Ridley & Co., of New York, which dates from the year 1806, and whose modest parent establishment, at No. 1 Hudson Street, and which is shown by the cut accompanying this article, is still occupied by the firm, another larger sales-room having also been opened in connection with their up-town manufactory at No. 1149 Broadway.

The original founders of the house were succeeded by the present partners in May, 1856, after just half a century of honest and prosperous dealing. The firm now consists of Messrs. Robert A. Ridley, William A. Fritz, William Kennedy, and William Force, all

of whom were apprentices to the old firm. Mr. Fritz, who was twenty years with the old firm, is at present business manager.

Ridley & Co. do not thus far experience any temptation to vary from the traditions of the concern. They use no materials whatever in their business except the purest and best. Their sugar is sugar, and neither sulphate of lime nor wheat flour, and it is the best refined loaf sugar, too. Their honey is honey, and not mo-



MANUFACTORY OF RIDLEY & CO., NEW YORK.

lasses; their gum is gum arabic, and not glucose; their licorice is licorice, and not a compound of lampblack and glue; their vanilla is vanilla, and not Tonquin beans; their flavoring extracts are made by themselves; no deleterious article whatever is used in their business for flavoring, color, or ingredient of any kind.

The high principle of morality, which prevents this standard firm from the profitable swindling which has been described, is consistently adhered to, not only in their process of manufacture,

but throughout their whole business. Thus, for instance, the firm will not deal in what are called "brandy-balls," "cordial drops," nor any of the kinds of candy which contain alcoholic fluids, nor will they deal in the gambling stuff known as "prize candies." As befits the truly honorable merchant, they will not trade either upon the bodies or the souls of men. The economical organization of their business, and their extensive and successful use of steam processes in manufacture, show at the same time that they possess a full share of intelligence and enterprise.

The materials used in Ridley & Co.'s extensive business are much more numerous and varied than might be imagined; but they present a singularly agreeable array of things wholesome, flavorsome, delicate, and aromatic. They include, first and chiefest, sugar; then the auxiliary substantials of honey, molasses, cream, gum arabic, almonds, filberts, cocoanuts, peanuts, chocolate, liquorice, jujube, flax seed, coriander seed, caraways, cinnamon (i. e., the cassia of commerce), cloves, and Iceland moss. Next are the flavors, which are birch, boneset, cayenne pepper, cinnamon, ginger, hoarhound, lemon, musk, peppermint, raspberry, rose, sassafras, vanilla, and wintergreen. Then come the coloring matters, viz.: cochineal, indigo, and saffron. Last are what may be called the literary and military styles of confectionery, namely, "mottoes" and "torpedo mottoes." The former are either those which are infolded with a motto or rhymed couplet, or certain so-called "conversation lozenges," each having a brief remark, question, or answer printed upon its face in bright red letters. As for the second or military confectionery, this simply consists of motto candy, accompanied with a kind of small torpedo that goes off when pulled, with a delicate pop just loud enough to please a young lady.

As for the forms which are given to these substances, they are still more various. Candy is manufactured into rock, sticks, bars, lumps, braids, crystallized, plums, kisses, comfits, drops, lozenges, nonpareils, and broken candy. All these are manufactured of all combinations, flavors, and colors, and they are put up in boxes, parcels, and cornets.

Thus there are used in the confectionery business between thirty and forty different kinds of materials. These are manufactured into several hundred different styles of candy.

The processes of the manufacture are not without their interest, although a detailed account of them would be suitable only for scientific or commercial purposes. All the sugar used is bought

of the best quality, and is carefully clarified besides. No candy, except lozenges, is made without heat; the principal process being to boil a strong sirup of sugar in the proper manner, and then to manipulate it in a proper manner for crystallizing, or to color it and shape it for drying into its various forms. The quantity of labor bestowed, both by machinery and by hand, is enormous. Take, for instance, one of those common, round, rough-surfaced sugar-plums, about half an inch in diameter, which are made of various colors, some white, some red, etc. Split one of these in two; you can see numerous concentric circles all the way from the coriander seed, which is the nucleus, out to the surface. Each of these circles is the evidence of one dip in the sugar, and a subsequent drying. Before this little globe was finished, this dipping and drying had to be repeated two hundred or even three hundred times. It is true that a large tray or panful is thus treated all at once; if each had to be made alone, sugar-plums would be practically unattainable. Machinery and division of labor have rendered them cheap, however; and these being the two great triumphs of modern industry, it is evident that a great deal of civilization goes into a sugar-plum.

King George, according to an old story, was once greatly mystified with the fact that an apple could be inside of a dumpling, without any sign of its entrance therein. A similar question has often puzzled the uninstructed mind about the cream in cream chocolate drops, and the jelly-like material in the so-called "jelly drops," and in soft gum drops. As for the chocolate drops, the answer is only this: the inner lump of "cream" — it is nothing but a lump of very fine, soft sugar — is made first, and then dipped into a thick paste of chocolate, which clings to it and hardens upon it. The structure of the jelly drops is one grade more complicated, depending on the fact that a thick sirup of gum and sugar, and indeed of sugar alone, ready to crystallize, always begins to do so on the surface, the interior changing last, because it is thus shut out from the free action of air and light. A properly-shaped lump of such sirup, ready flavored and mixed, is therefore placed by itself; it quickly hardens or crystallizes on the outside, and the rest is the "jelly." Keep it long enough, and that crystallizes or dries up also.

There is a well-known scale of the degrees of heat and continuance of boiling, which produce certain scientific effects upon sugar. Warm water simply dissolves it more readily than cold. Boil, for

instance, in a proper vessel, fine loaf sugar with water, at three gills of water to a pound of sugar, and two minutes' boiling will bring the solution to what is called "the thread," i. e., to a state where it will draw out into a short thread; a few moments more, and it is at the "pearl," that is, bubbles like pearls appear on its surface; and so on. After a little, a small portion dropped into cold water can be rolled into a ball by the hand; a little more, and it becomes dryer, and will crack; then it begins to grow brown, and turns into what is called in the shops caramel; and the baking can be carried still further, until the sugar becomes nothing but charcoal. The sugar is used for one or another kind of confectionery, at one or another of these various stages of boiling, as the work requires.

Messrs. Ridley & Co have no regular war department; the torpedoes, which they use for "torpedo mottoes," being imported ready for use. The mottoes, which are used in the candy of that name, have themselves been composed by unknown poets, and consist usually of two-line or four-line stanzas, amatory, complimentary, or sarcastic. Of these compositions there is a wonderful variety, the stock possessed by the firm reaching to about ten thousand different mottoes. Of thirteen of these poetical efforts, picked up at random from a lot in an open basket, every one turned out to belong to the affectionate kind, belonging to classes such as we find described in the indexes to hymn-books by words like "invitation" and "expostulation," etc.; and it may be observed that there is a notable equality between the sexes as regards taking the initiative. One, for instance, suitable for a bold young thing, says, —

> "This motto is sent, and sent by a miss,
> Who wishes you, sir, to return her the kiss."

This one, again, is for a melancholy and unsuccessful lover: —

> "How can the fair, for whom I daily pine,
> Prefer another's boasted love to mine?"

But most of them are ambiguous in regard to sex, being such gushes of affection as might fly either way, viz.: —

> "Together let us faithful twine
> A wreath that will our hearts combine."

No specimens from any of the classic English poets in particular

were observed, though it might be imagined that such a selection would be just as loving as these, and a good deal more poetical. Why not, for instance, use these? —

> "O, woman, in our hours of ease,
> Uncertain, coy, and hard to please!"
>
> "If to her share some female errors fall,
> Look on her face, and you'll forget them all."
>
> "Maid of beauty, ere we part,
> Give, O, give me back my heart!"

However, this very experiment has been made, and it has failed. A sufficient number of couplets and stanzas could not be found having at once the completeness of form and the peculiar signification required. There are, perhaps, enough abstract and general compliments and declarations of love; but a brief rhymed request to be allowed to see a young lady home, or an invitation from her to a young gentleman to do so, it would be hard to select; and such homely, every-day suggestions as those are the most useful "mottoes;" for they save the blushes and shyness of many a loving but awkward heart.

Allusion has been made to the steady and long-continued business success which has attended the operations of this firm, already of a patriarchal standing among American business houses. It does not even condescend to employ those energetic and voluble representatives of the spirit of modern business, known as "drummers." Nevertheless, the transactions of the house of Ridley & Co. reach all parts of the United States, and many other countries besides, as various parts of South America, London, Paris, China, etc., etc.

The series of circumstances which ended in the establishment of one of these business correspondences in particular is interesting enough to be related somewhat in detail. Quite a number of years ago, her grace the Duchess of Sutherland called one morning on her friend, Mrs. Bates, the wife of the late Joshua Bates, the well-known American member (since dead) of the great banking firm of Baring Bros. & Co. Observing that the duchess had a cold, Mrs. Bates gave her some hoarhound candy to use as a remedy. The duchess, finding it of great service, afterwards recommended it to the queen, who tried it with equal success, and the London firm of De Castro & Co., grocers to the queen, were

soon commanded to supply her majesty with a further quantity of the article. As Mrs. Bates had obtained it from Messrs. Ridley & Co., the order was sent to them; and Ridley & Co. have ever since been supplying Queen Victoria and her family, and the London market besides, with hoarhound candy, sending considerable shipments monthly, or even oftener. It is an additional proof of the excellence of Ridley & Co.'s candy, that counterfeits of it are constantly on sale all over London.

The extent of the business of Messrs. Ridley & Co., as well as its duration in time, is ample proof of the unnecessary nature of the impositions which have been alluded to in the previous pages. The sugar which they use is counted by thousands and thousands of barrels a year. In preparing one of their styles of candy alone they use annually a quantity of dried hoarhound leaf equal in bulk to a good large haystack. Their printer's bill alone is some two thousand dollars a year. Indeed, as long as there is so ample a field for profit, with the purest integrity in supplying the sweets of life, it is peculiarly strange that the substitution of poisons and rubbish should be so extensively practised.

SUGAR REFINING.

EXTENT OF THE BUSINESS. — OLD METHODS. — MODERN PROCESSES. — SUGAR REFINERIES. — LOAF, CRYSTAL, AND CRUSHED SUGARS. — TREATMENT OF RAW SUGAR. — REMOVAL OF COLOR AND IMPURITIES. — GRANULATION. — THE VACUUM PAN. — LIQUORING. — MOULDING. — OTHER PROCESSES. — MAPLE SUGAR. — WHERE AND HOW IT IS MANUFACTURED. — SORGHUM.

Sugar Refining is carried on to a very large extent in New York city, and in nearly every other leading city in the United States. The process is for the purpose of removing the impurities and coloring matter from raw sugar, as imported, and producing pure white loaf sugar, crystals, — large crystal or "coffee sugar," — and crushed and pulverized sugar. These classes of refined sugars may be made in one large establishment, or in different establishments devoted to the production of a particular class. The process of refining, in its rudest form, is exceedingly ancient, and was practised in England in the sixteenth century. For many years the method of refining was to add to the solution of raw sugar blood, eggs, and lime water to neutralize acid; heat was then applied, the scum was removed, the semi-crystallized solution was poured into moulds to drain, and the hardened loaves were trimmed, dried, papered, and were ready for market. This process is almost entirely superseded by a more perfect form of filtration, which removes the color and impurities with far less waste of sugar.

The refineries are immense buildings, six or seven stories high, to admit of the various processes in the different stories, beginning at the top floor. On this floor the hogsheads and boxes are emptied, the sugar is put into copper "dissolving pans," about eight feet in diameter, and hot water is added. The solution is raised to the required heat by means of the steam-heated coils which encase the pans. From the pans the sirup passes through

filters, which are long bags of thick, twilled cotton cloth, arranged in rows, and which are kept warm by steam. From these bags the liquor runs free from most of its impurities, but still colored. To remove the color, the liquor is passed through iron cylinders of from five to ten feet in diameter, and (now) of fifty feet in height, filled with animal charcoal, or "bone black." This charcoal is granulated, and, after thorough cleansing and reburning, it recovers a portion of its power, and may be re-used.

From these charcoal cylinders the sirup comes out perfectly colorless, and is removed to the "vacuum pan" for evaporation and crystallization. The more rapidly this is effected, the more sugar will result. The evaporation begins at a temperature of from one hundred and seventy to one hundred and eighty degrees, and, when granulation begins, is reduced to one hundred and sixty degrees, and gradually to one hundred and forty-five degrees. From the vacuum pan the sugar goes to a heating pan, similar to the dissolving pan, where it is raised to a temperature of one hundred and eighty degrees, being constantly stirred during the heating, and is then drawn off, and poured into conical iron moulds, and left to drain. After several hours the loaves are "liquored" by pouring in at the top a perfectly clear solution of pure sugar, which effectually removes every remaining particle of coloring matter. If necessary, the liquoring process is repeated till the loaves are perfectly blanched, when they are taken to a steam-heated drying-room for two or three days; are then trimmed, if necessary, in a lathe; are papered, and are ready for market as the best quality of "loaf sugar." The drainings from the moulds, trimmings, etc., are saved for the manufacture of inferior grades of sugar.

In the manufacturing of crystal and crushed sugar, the preliminary processes are the same as for loaf sugar, but raw sugars of an inferior quality may be used. The vacuum pans are larger, and for the formation of large crystals the pan is first partially filled, and, as crystallization begins and continues, fresh liquor is introduced from time to time, till the process is complete. The crystals, while in a semi-fluid mass, are separated by means of a "centrifugal machine." In crushed sugar the process is similar to that of making loaf sugar, excepting that the filtration is less complete, and liquoring is dispensed with. Much of the best white sugar now sold in American cities is sent to market, not in loaves, but in small, square-cut lumps, and the cut, crushed, and pulverized sugar is put up in barrels.

Maple Sugar.

The manufacture of maple sugar, which has been carried on for more than one hundred years in New England, has now attained considerable importance in that section, in New York, in Pennsylvania, in Ohio, in Michigan, and in other northern and western states. The sugar is made in February and March, from the sap of the sugar maple. Holes three fourths of an inch in diameter are bored in the trees, not more than half an inch into the wood; elder wood split tubes are inserted, and the sap, as it flows, is caught in pails or troughs. The sap is boiled over an active fire, is repeatedly skimmed, and when it assumes the consistency of sirup, it is strained through woollen cloths. It is then reboiled to granulating consistency, when it is poured into moulds, from which the molasses drains away, leaving light-brown cakes of sugar. Many farmers make their entire supply of sugar for home consumption from the maple; it is "run" into cakes, for sale by grocers and confectioners in cities; and it is susceptible, by refining, of conversion into pure white sugar.

In 1856 the seed of the Chinese sugar-cane, or sugar variety of the sorghum, was introduced into the United States, and its cultivation was begun somewhat extensively, especially at the West. It grows readily in soil and climate where Indian corn can be raised, but will not ripen perfectly north of 42° north latitude. Like the mulberry and petroleum, sorghum became a mania, and for a year or two the papers were filled with accounts of its production and profit, and the probability of its ultimately superseding the sugar-cane of Cuba and the South. It was soon discovered, however, that its chief value was for sirup, from one hundred and fifty to four hundred gallons of which can be produced to the acre, while the production of the crystallized cane sugar from the juice is quite small. For molasses, or sirup, the sorghum cane is extensively cultivated, and in some sections of the country it furnishes almost the sole supply of this article.

Quite recently successful experiments have been made in the United States, particularly in Illinois, in making sugar from the French white sugar beet. The manufacture in France for many years past has been extensive and profitable, and there is little doubt that it may become an important industry in this country.

FIRE DEPARTMENT SUPPLIES.

FIRE AS A SERVANT, AND AS A MASTER. — IMPROVEMENTS IN BUILDING. — EXAMPLES OF CONFLAGRATIONS. — THE GREAT FIRE IN LONDON. — FIRES IN ROME. — INVENTIONS FOR PUTTING THEM OUT. — THE FIRST FIRE ENGINE OF MODERN TIMES. — THE AIR CHAMBER INTRODUCED. — HOSE FIRST INVENTED. — FIRE SYRINGES. — THE STEAM FIRE ENGINE. — THE FIRE DEPARTMENT OF PARIS. — OF LONDON. — IN THE UNITED STATES. — THE FIRST SUCCESSFUL USE OF STEAM FIRE ENGINES. — THE PRESENT APPARATUS USED BY FIRE DEPARTMENTS. — THE INVENTIONS OF A. F. ALLEN, OF PROVIDENCE, R. I. — THE SPRAY NOZZLE. — AN AUTOMATIC RELIEF VALVE. — TELEGRAPHING THROUGH THE HOSE. — THE NEW ERA IN FIGHTING FIRE.

THE services of fire, when under man's control, are so important and valuable, that we cannot wonder that the ancients, with the child-like tendency of personifying the objects about them, should have ascribed its discovery to the agency of the gods; or that some nations of the East should have worshipped it as the symbol of the divine power which created and sustains the universe. To the race of mankind while still in the pastoral condition, while living in tents, and in sparsely-settled communities, this beneficent aspect of fire is more readily suggested. But when with increasing numbers men became aggregated into cities, and industry becoming specialized, greater attention and labor were bestowed upon their dwellings, while the fruits of their varied toil came to be gathered and stored in vast depositories, the terrors of fire as a master, as a raging devourer of all that they prized, became more vividly impressed upon their minds, and fire was made the attribute of demons rather than of divinities, becoming a symbol of destruction rather than of service.

Though there is hardly any modern city which has not suffered from a conflagration of greater or less extent, and in whose history, if it is old enough to have a history, some destructive

fire does not form an era from which dates are computed, and the memory of which is still preserved among the old survivors, who never tire of recounting the fearful horrors of that terrible night when the horizon was lit with the lurid flames, and men could wander about in a light as bright as day, with the sad consciousness that it was made by the destruction of their homes, yet still our modern cities are more secure than those of olden times.

In the advancing march of human dominion over the earth, men have come to use for the construction of their habitations the more incombustible materials, brick, stone, and iron replacing wood. Yet our houses are still very far from being incombustible, and it is only by comparing them with the structures made entirely of wood, which formed the bulk of our cities during the preceding century, that their advantage in this respect becomes apparent.

The number of cathedrals built of stone, which have been burned by the woodwork of the interior finish, together with the total destruction, in about half an hour after the fire was discovered, of the Crystal Palace in New York, which was constructed of iron and glass, and the partial burning of the Crystal Palace at Sydenham, built of the same material, show that it is difficult to construct a building which shall be really indestructible by fire. In York Cathedral, for example, though the solid stone walls were uninjured, yet the flames from the woodwork inside, the pews, the choir, and the screens, set fire to the woodwork of the noble oak roof, covered with slate, and on the two occasions on which this building has been burned, in 1829 and in 1840, utterly destroyed it, though it is hung at an elevation of over one hundred feet from the main floor.

In the New York Crystal Palace, the pine floors, the wooden stairs, and the tables for the exhibitors, made such an intense heat as to fracture the glass, and fuse much of the iron used in the construction of the outside. The rapidity with which this conflagration spread was surprising. It began in a lumber-room, used for the storage of benches and things of that kind, and though at first it could have been extinguished with a pitcher of water, yet in less than a half hour it had reduced the entire building to a shapeless mass of ruins. Once started, the flames ran along the pitch pine floors, which had been drying and seasoning for a year or two, as though they were so much tinder, and hardly allowed time for the throng of visitors who were present when the fire

began, to save themselves, before the whole building fell into ruins.

The great fire of London, in 1666, lasted four days and four nights, and reduced five-sixths of the city to ruins; nor was this the only time that London had suffered, almost as severely, from conflagrations which the inhabitants had found too powerful to restrain, though since then no such terrible fire has obtained the mastery of means in use for controlling it.

In this country, our chief cities have all experienced the terrors of a great fire; and the recent conflagration in Portland, Maine, occurred so little while ago, that the impression it produced upon the public mind has not yet died away. In Rome, as we learn from its mention by some of the ancient Latin authors, an invention called a *sipho* had been made for the purpose of putting out fires when they occurred. As none of these writers has happened to describe it, it is impossible to tell how it was constructed; and some critics have therefore thought it was rather an arrangement for supplying water to the houses for domestic use, than an apparatus for putting out fires. Even if it was, however, the germ of a fire department, it could not have been very effectual, since Seneca remarks that the houses in Rome were so high that when they took fire it was impossible to put it out.

Though the Romans built aqueducts for the supply of their cities with water, yet they were unacquainted with the properties of this fluid, and that in enclosed pipes it will rise to the level of its source, so that their aqueducts were carried on a level, often at a great outlay of labor. Yet they were not unacquainted with the use of pipes, for siphons were in use among the Egyptians at a very early age, and frequently in antiquity were used for draining lakes, or transferring water from one reservoir to another, over an intervening obstacle.

Though the houses in Rome were peculiarly liable from their material to be destroyed by fire, and they had a supply from their aqueducts which was much larger in proportion to the number of their population than modern cities generally have, yet the first suggestion for using water as a defence against fire was made as late as the Empire, by the architect Apollodorus, who suggested the use of a kind of hose, made of the intestines of an ox, to which was attached a bag filled with water. By pressure upon the bag, the water could be forced through the tube, thus obtained, and raised to an elevated place. His suggestion was

originally made for the purpose of supplying water to besieged places, which were exposed to the arrows and fiery darts of the enemy, but was most probably used also for fighting fire.

In Europe, during the middle ages, the chief means used as a protection against fire was prevention. The curfew bell was the signal given in the early evening for extinguishing all the fires used for domestic purposes. The term is derived from the French *couvre feu*, meaning cover up the fire.

In Germany, during the fifteenth and sixteenth centuries, fires were of frequent occurrence. The cities of that country were in those days built in a very crowded manner, and chiefly of wood. The necessity for walling the towns during this period, in order to protect their inhabitants from the raids and forays of the neighboring barons, who maintained their wealth by preying forcibly upon every industrious community within easy reach, obliged the inhabitants of the towns to live in confined quarters. Besides, too, at this time the sanitary measures used in our cities were ignored, and the streets were so narrow as to be frequently little more than footpaths, so that fire was easily communicated from the houses upon one side to those on the other. The frequency of destructive fires led to the issue, in Germany, during these centuries, of numerous ordinances regulating the construction of houses, and the methods to be used for preventing fires.

The first machines, however, intended to put out fires, of which we have any accurate notice, were in use in Augsburg in 1518. These were called "instruments for fires," and "water syringes useful at fires," this last name pretty effectually describing what these "fire engines" were. The Jesuit Caspar Schott describes one of these which he saw in Nuremberg, in 1657, and says, that forty years before he saw a similar one, though smaller, in Konigshofen, his natal city. He describes the one in Nuremberg as having a barrel for the water, eight feet long, four feet high, and two feet wide. The piston was forced up by twenty-eight men, and threw a stream of water, one inch in diameter, a distance of eighty feet. It was carried about on a sledge, ten feet long and four feet broad, drawn by two horses. In front it had a short, flexible pipe, by which the stream could be directed from one side to the other.

He makes no mention of any air chamber connected with it, and evidently it was simply an enormous syringe, with which the water was driven by the force applied to the piston. Such a

machine must have been quite clumsy to handle, and of not much efficacy, since it had no suction pipe, and would have to be filled when its charge was expended.

In 1684 Perrault describes engines in use in Paris for extinguishing fires. One of these he speaks of as being in the king's library, threw a continuous stream of water, though it had but one chamber; and as this is supposed to have been done by the use of an air chamber, this account is said to be the first mention of the use of this device in fire engines. In 1699, a special officer was appointed by the King of France, with the duty of constructing, and keeping in repair, and using at fires, the seventeen "portable pumps," which then constituted the force in the royal service. In 1722 the number of these pumps had increased to thirty; but as none of these were provided with separate air chambers, it is most probable that the one previously spoken of did not have any. This opinion is strengthened by the fact, that in the *Mémoires* of the Academy of Sciences, in Paris, for the year 1725, an account is given of the introduction of such an improvement in the engines at Strasburg, while no intimation is given that those of Paris were built with the same device.

About the year 1670, hose made of leather were invented in Amsterdam, by two natives of that country, named Van der Heide, and the immediate introduction of their use showed how much the necessity had been felt for some such appliance.

Having afterwards invented the suction pipe, the same inventors, in 1690, published, in folio, an account of their improvements, under the title *Beschrijving der nieuwljkis uitgevonden Slang-Brand-Spuiten*. This volume was handsomely illustrated with plates, the first seven of which represented conflagrations, at which the old engines had been used with but little or no effect, while the last twelve depicted more recent fires, which had been extinguished by the use of the new engine, and showed the working of the machines. The details of the construction of the new engine are not given.

In England it was a long time before the improved methods of extinguishing fires were introduced from the continent. At the end of the sixteenth century, the only apparatus in use in London was a kind of hand syringe, holding about two or three quarts of water. Some of these are still preserved in the vestry-room of St. Dionis Backchurch, in Fenchurch Street, London. These required three men to work them. One man on each side held the

"engine" in his hands, while the third pressed up the piston, and forced out the water in a stream. When discharged, they were filled by taking out the piston, and immersing the "engine" in the water.

These syringes were afterwards fitted into a portable cistern, and the pistons arranged to be worked with levers. This arrangement continued in use until they were supplanted, about the end of the seventeenth century, by a new engine, invented and patented by Newsham. This was a cistern mounted upon wheels. It was provided with a suction hose, pumps, and an air chamber. The suction pipe was furnished with a spiral of metal to keep it distended when the air in it was exhausted, so as to prevent its collapsing before the water was drawn up into it. It had also a strainer, and when it could not be conveniently used, water was supplied to the cistern by being brought in buckets.

During the eighteenth century, and until the commencement of this, the fire engine remained the same, in general character, as the one just described. Several improvements were made in the manner of working it, but it remained the same in principle. An improvement made in the early part of this century consisted in arranging twelve force pumps about a central air chamber. Each of these pumps could be worked separately, and only one man was required for each pump, so that the engine could be operated without waiting for the entire complement of men to arrive. It is said to have surpassed any other engine of the time in its capacity for throwing water, even when working with a smaller number of men.

During the early half of this century, and before the successful application of steam to fire engines, as still in many of the small towns, the engines in use consisted of two vertical double-acting force pumps, or sometimes four single-acting pumps, with an air chamber. These pumps are worked by brakes, consisting of a long handle, worked parallel with the engine, and enabling many men to work them together, and these engines are provided with separate hose carrriages, upon which a longer or shorter length of hose is carried, rolled upon a reel; and with them are also provided long ladders, and hooks placed upon long poles, which are carried upon separate carriages, and are used for pulling down the damaged walls of a building, or for other purposes.

In the United States these engines are worked generally by volunteer companies, who are usually made exempt from military

FIRE-ENGINE ON DUTY.

duty, and are, however, more or less dependent upon the state, and subject to the control of state officers. The friendly emulation encouraged between these companies has led to their taking great pride in the excellence of their engines, and these are frequently admirable specimens of mechanical workmanship, and beautifully ornamented.

In Paris the service at fires is performed by a regularly constituted body of men, under the control of the government. They are uniformed, are provided with various apparatus for saving the lives of persons in danger from a conflagration, and are trained systematically in all kinds of gymnastics, so as to be able to afford assistance in cases of difficulty. Members of this force are detailed at each of the theatres, and other places of public meetings, in order to be on hand in case of an emergency.

In London the fire service is in the pay of the insurance companies, and is regularly organized, provided with apparatus, and is very efficient. At first the suggestion to introduce steam fire engines to replace those worked by hand met with great opposition from the organized volunteer fire companies of this country, but the indisputable benefits of their introduction render it certain that, in time, wherever they can be used, they will replace the old method of hand engines.

The first attempt to produce a fire engine which should work by steam was made by Mr. Brathwaite, of London, England, in 1830. His first engine weighed a little over five thousand pounds, and had not quite six horse power. The boiler was upright, and generated steam in twenty minutes. It could throw about one hundred and fifty gallons a minute from eighty to ninety feet high. In 1832 Mr. Brathwaite built a second engine, constructed upon the same general principles, for the King of Prussia.

The great fire of 1835, in New York city, excited attention to the inadequacy of the means then in use to control a conflagration, and premiums were offered for plans of steam fire engines, and in 1841 a number of insurance companies associated themselves together, and contracted with Mr. Hodges for the construction of such an engine. This engine, when finished, performed excellent service at fires upon several occasions, but was found too heavy, and it was therefore sold.

The merit of having first successfully introduced the use of the steam fire engine, and having organized the fire department upon that basis, in a way which has secured an efficiency never before

attained, belongs to the city of Cincinnati. The first steam fire engine used there was designed and constructed by Mr. A. B. Latta, in the early part of 1853. This was a very powerful engine, weighing about twelve tons; and though its own steam was applied to its wheels as a propelling force, yet it required four horses to drag it. The next year he built two others of the same kind, but the machines now in use do not depend upon the steam as an aid to their propulsion, while the weight of many, including the water in their boilers, has been reduced to less than five tons, so that they are easily hauled by two horses.

In 1859 a steam fire engine was built in New York, to be drawn by hand. Its weight was but little over five thousand pounds, and yet it discharged nearly five hundred gallons a minute, throwing a stream measuring one and one-eighth inches to a height of one hundred and eighty-five feet. The use of steam fire engines, being thus successfully inaugurated, has extended in every direction, and the ingenuity of inventors has been chiefly turned towards improving the appliances used in connection with them, so that the efficiency of our apparatus for controlling fires shall be increased, and a greater economy of labor be secured, with the same or less expenditure of force.

The materials now at hand for forming the stock of a well organized and provided fire department compare with those in use in the days of "hand syringes," very much as the modern steam ship compares with the canoe with which the aboriginal savage navigated our streams, or as the locomotive with its train of palace cars compares with the journeys on foot made by the same people.

A visit to the establishment of Albert F. Allen, of Providence, would furnish the reader with the best data for making such a comparison. Here a fire department can find everything needed for their purposes, from a steam fire engine down to a hose wrench. Mr. Allen has himself done much to improve the appliances in use by the fire department, and having practical experience of what was needed to perfect the arrangements for subduing a conflagration, he has turned his inventive abilities towards supplying them, and has succeeded, though still a young man, in establishing for himself a reputation as the leading inventor of the country in this department, and for his house as the representative house in the United States for its special branch of business.

In 1867 he patented an "escape valve coupling," which operated with a hand wrench, and was the first step in the much

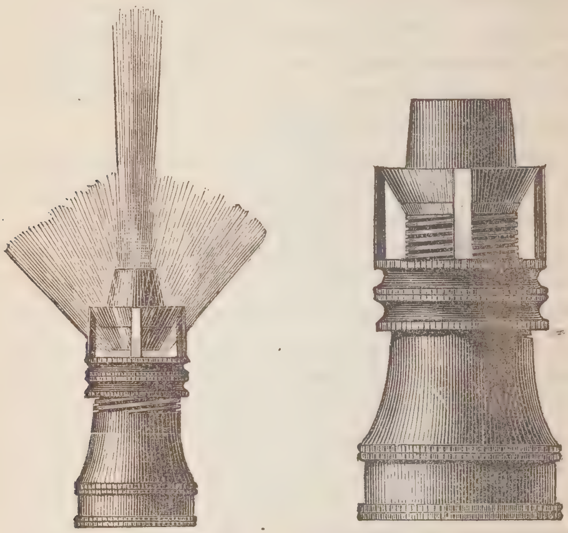
WAREROOMS OF ALBERT F. ALLEN, PROVIDENCE, R. I.

needed direction towards giving the hosemen control over the delivery of water from the pipe, preventing thus the unnecessary flooding of water, and also diminishing the unnecessary strain upon the hose. His next invention was a "signal hose wrench," which was a necessity for operating the escape-valve coupling quickly enough to establish a signal; the signal hose wrench turning either way, and not requiring to be changed, like the old form of wrench. In 1869, he patented an improved screw coupling, and an improved spray nozzle. The wide acceptance these have met with show at once the need there was for such improvements, and how these supplied it.

The improved screw coupling is an ingenious, though simple invention, which may be described as consisting of a male and female "butt," the former of which is constituted of a band and a "tail-piece," the latter of a band, tail-piece, and swivel; the bands being made each with an inside shoulder, on which fine threads are cut. The screw ends of these butts, to which threaded shanks to match are attached, are firmly screwed together, forming a perfectly tight joint, through which it is impossible for a particle of leakage to occur, and effectually capping the ends of the hose, preventing all moisture from entering either from the outside or inside at the end of the hose, between the lining and covering of a rubber hose, for example, when used, thus preventing the destruction of the same by mildew and rot. The coupling is also provided with a very essential guide, or "blank," which protects the end of the thread when dragged over pavements, etc., and which, when placed in the swivelled female coupling, acts as a guide, preventing the crossing of the threads, and enabling the butts to be coupled instantly, as well in the dark as in the light. The screw coupling is the only reliable one, the fancy-clutch coupling and like devices being now entirely discarded in experienced fire departments. The improved screw and ring coupling of Mr. Allen is the only one which has never been "blown off," or detached from the hose under pressure.

The "spray nozzle" is a most admirable contrivance, by which the pipeman is protected from the heat of a raging fire, so that he can approach close up to it, and direct the stream of water where it will prove most effective. The spray from this nozzle, rising in the shape of a cone, places a watery screen between the pipeman and the heat of the fire, while at the same time driving back the smoke, and securing him a supply of fresh air. Nor does its use

injure the power of the stream of water from the pipe, nor affect its volume. Thus the fireman is more effectually protected in his dangerous work, in a purely scientific way, than if he were clothed in a suit of asbestos, since at the same time his sight and his breathing are in no way obstructed.



SPRAY NOZZLES.

Mr. Allen's next important invention was the hose and ladder strap, which supplied a great and long felt need, saving an immense amount of hard labor to firemen, and frequently their health and lives. This device is now in general use throughout the country.

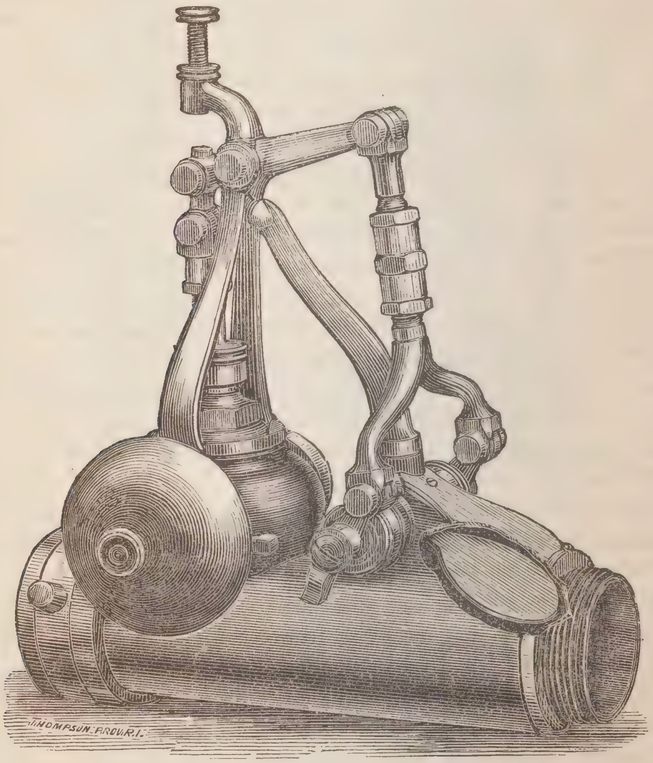
Mr. Allen has also invented an improved suction hose, which combines lightness with the requisite strength. Perhaps, however, the most important of his inventions, since it inaugurates almost a new method of treatment for the work of overcoming fires, is his "Automatic Relief Valve," which was patented in April, 1871. It is evident from the advantages this new arrangement gives of prompt and reliable intercommunication between the pipeman and the engineer, no matter how long nor how devious may be the length of the hose which separates them, that it wants only to become known to be brought immediately into general use.

The object of this automatic relief valve is first to place the control of the supply of water under the immediate direction of the pipeman. He is stationed at the point where he can see how much water is required, or whether the supply is too great, and by a simple motion of the hand he notifies the engineer whether to increase or diminish the supply of water, or the force of the stream. This method of telegraphing by the stream of water was first suggested to Mr. Allen's mind when he invented his escape valve coupling. By this invention the hoseman having the power to instantly lessen or increase the size of the stream, by opening and closing the coupling, he found that such increase or diminution affected in a few seconds the further end of the stream. With the invention of the automatic relief valve, this system of telegraphing has been perfected. The pipeman by a motion of his hand can instantly stop the stream of water, and as instantly commence it again, and with the stoppage of the water, the automatic relief valve, which has been kept closed by the velocity of the stream upon a hydraulic lever, is instantly opened by the pressure of the water upon the relief valve; and the supply of water is directed from the relief valve to the suction pipe, and thus circulates without entering the hose, until the pipeman, opening the nozzle again, the current of water upon the hydraulic lever closes the relief valve instantaneously, and the water again flows through the hose at the pipe.

As the stream is cut off, and the valve opened, the falling of the hydraulic lever moves a hammer which strikes a gong, and thus gives notice to the engineer. By a simple set of prearranged signals, it is thus easy for the pipeman to communicate with the engineer, and notify him either to increase or diminish the supply. At the same time also, when the stream is cut off by the pipeman, the action of the automatic valve cuts off the supply to the hose, thus stopping the strain upon it, without stopping the action of the engine. The importance of this invention, which thus introduces a unity of action between the two ends of the line of hose, practically enabling the pipeman and the engineer to converse with each other, however far they may be separated, will be evident at a glance to any one practically acquainted with the working of fire engines, while its value will be equally evident to those who have suffered at fires by the destruction of goods flooded with water, on account of the delay which heretofore existed in the communication between the pipeman and the engineer.

The fire department, thus armed with such scientific appliances as the spray nozzle and the automatic relief valve, can approach the seat of the fiercest conflagration, and without any waste of water, apply the deluge furnished by the steam engines, in the most economic and efficacious manner.

Through the whole range of modern invention, by which mankind to-day apply their scientific knowledge of the properties of



AUTOMATIC RELIEF VALVE.

matter to furthering their needs for comfort and protection, there is no more striking and pleasing example than this, by which the dominion of human energy over the raging destruction of fire appears to be almost entirely secured; and it is a pleasure to extend the knowledge of such valuable inventions among those who are to be so benefited by their introduction into practical use.

BRUSHES AND THEIR MANUFACTURE.

THE IMPORTANCE OF THE BRUSH. — ITS USE IN DAILY LIFE. — DERIVATION OF THE WORD. — SUPPLY AND DEMAND. — BRUSHES IN ANTIQUITY. — IN THE MIDDLE AGES. — THE INTRODUCTION OF BRISTLES. — THEIR SUPPLY. — OTHER MATERIALS. — PREPARATORY PROCESSES. — MANUFACTURE OF BRUSHES. — THE LEADING MANUFACTORY IN THE UNITED STATES. — THE VARIETY OF ITS WARES. — THE HISTORY OF ITS FOUNDATION. — CHARACTERISTIC ANECDOTE. — EARLY IMPORTATION OF FINE BRUSHES. — INTRODUCTION OF WORKMEN.— THE PRINCIPLES UPON WHICH THE MANUFACTORY IS ORGANIZED. — ITS SUCCESSFUL RESULT.

THE brush, as a utensil in modern industry, and as also an appliance of daily life, holds a much more important position than is usually supposed. The cleanliness and propriety of modern civilization can almost be said to be based on the brush. In the care of our persons, our clothes, our houses, our furniture, our streets, our carriages, our public conveyances, our live stock, we have a constant need of brushes; and for these various purposes they are prepared in as various forms, and from as various materials.

We rise in the morning, and, — prepared to meet our fellows by the use of the flesh brush, the hair brush, the nail brush, the tooth brush, — we robe ourselves in well-brushed clothes, put on our brushed shoes, and descend over brushed stairways to breakfast in a room that has been well brushed and swept. In the preparation of the painted china upon which we eat, a brush has played a necessary part; the burnished urn is an evidence of its use; and when the meal is eaten, a brush removes the fragments that remain. Thence, through streets which have been cleaned with brushes, we go to offices kept clean by the use of similar appliances; and thus we pass down the well-brushed pathway of

life, to take final refuge in a coffin which has been varnished by a brush.

Our brushes are often made of bristles, but bristle and brush are both derived from the same root; and the fox's brush, the bristling bayonets of an army, the fear of an approaching brush which leads us to brush up our wits, and devise some method of escaping it, all show how the use of language changes, and words, by the effect of imagination or comparison, come to be used in metaphorical and fanciful senses.

The use of brushes has greatly increased in modern times; and it is a singular fact in this branch of manufacture, that, while the demand for brushes seems to be capable of indefinite extension, the supply of the bristles, the chief material of which they are made, does not appear to be capable of anything like a proportionate increase. This difficulty in the practical working of the theory of supply and demand is met by an increase in the price of brushes, by which the consumption is checked, and by constantly impressing into the service new materials for their manufacture.

Among the nations of antiquity, brushes, as we have them now, were unknown, and for the purposes to which we apply them they used various substitutes. Among the Greeks and Romans the comb was used for dressing the hair, and they probably had some appliance to partially take the place of the brush. The Roman ladies were very particular in their head-dresses—plaiting, crimping and frizzling their hair, and supplementing its limited supply with even a greater variety of materials than our ladies now use. So desirous, also, were the fashionable ladies of that time to have their hair dressed always in the latest style, that their portrait busts were so arranged that the portion representing the head-dress could be removed, and replaced with a portion made to fit and representing the latest style of hair-dressing as the fashions changed.

For the flesh-brush which we use, the Romans had a metallic scraper, called a *strigil,* which was curved, and numerous specimens of which have been preserved, and are now to be seen in our museums.

In the middle ages the comb was also the chief implement used in the toilet of the hair, and it was made of fine materials, such as ivory, often of the precious metals, and was handsomely carved and decorated.

In modern times, however, brushes are made of a great variety of materials, according to the purpose for which they are to be used, and varying in their stiffness. Brushes for scrubbing the surfaces of metals are made of wire. Brushes of twigs, rattan, whalebone, and wood are used for coarse work, and so on up to those made of the finest and most carefully selected hair, for artists' use, and of choice feathers for dusting.

Most probably many of these materials were used in all times for similar purposes; but the use of bristles belongs to quite a modern date in history.

The bristles used in brushes are chiefly those obtained from the hog; and of these the best are obtained from the wild hogs in the north of Europe, the largest proportion coming from Russia, this country contributing nearly five-sixths of the entire supply.

The demand in this country has more than doubled in the past three years. Besides bristles, the hair of the badger, the squirrel, the sable, the bear, the horse, and other animals, is used for making brushes. For artists' pencils the hair of the ichneumon is used, while a portion of the supply is furnished from the hair cut from the ears of cows. In fact, it would appear that the hair from any animal whose skin produces straight hair may yet be used for this purpose. The supply may be so much increased, without any fear of outstripping the demand, that invention and experiment are busy at work devising new methods of treating the hair, so as to overcome the technical difficulties which have heretofore stood in the way of its use for this purpose.

The cheaper materials for brushes, which do not require much elasticity, and which are used for the coarser work, such as rattan, whalebone, or shavings of wood, form but a small part in the general trade of the country.

For the finer brushes, however, the first thing necessary is to secure the animal which is to furnish the material. This industry of itself furnishes occupation to innumerable hunters, scattered all over the surface of the globe. The animal being caught, and his hair, or bristles, as the case may be, being shaved off, only the preliminary step has been taken in preparing the material obtained for being converted into brushes.

As the bristles are received by the manufacturer, though they may appear to have been carefully washed and cleaned, yet they have to go through an elaborate cleansing process before they are really fitted for his purpose. The necessity for doing this

thoroughly makes the item of soap a by no means inconsiderable one in an estimate of the cost of production of brushes.

Then, or before being washed, the bristles are sorted according to their color, unless they are obtained by the manufacturer in this condition. The classification thus made is into white, black, gray, yellow, and lilies, or pure white. The white are then bleached with sulphur, or by other chemical agents, and the bristles are again sorted, according to their length and their quality.

The process for doing this is simpler than it would seem. A bunch of them is taken in the hand and passed through a species of comb, which catches and removes the coarser bristles. By repeating this process, using each time a finer comb, the bristles are assorted into heaps of as many different sizes as desired. Care must be exercised, during this process, to keep them always arranged in a uniform way, all of the large ends or the small ends pointing the same way. This process of combing, which is technically called *dragging*, is done upon benches, upon which the combs are fixed.

When the bristles are thus assorted they are then ready for the brush-makers. In the process of brush-making each operator makes his certain special variety of brush. There is no division of labor, but the entire process is done by a single hand, except in the cases where, as with hair brushes and some other kinds, the brushes have to pass afterwards into the hands of a cabinet-maker to be finished for market, by having backs glued on them.

The packing, papering, labelling, and other processes of preparing them for shipment, are generally done by boys or girls. In arranging the fibres for paint brushes of all kinds, the chief object is to so place them that their ends shall come to a central point; and in the finer kinds of brushes, especially those to be used by artists, skill in manipulation is required to do this successfully.

In making other kinds of brushes, in which the bristles are set into holes bored into backs of any various material, the bunches of bristles are dipped into hot pitch or glue, then tied, dipped again, and quickly inserted in the holes prepared, where a twisting motion is given them, and the hardening of the pitch secures them.

A stiffer brush is made by doubling the bristles, so that it makes a loop, with the two points projecting.

In other brushes the bristles are fastened with wire. The backs having been prepared, with holes bored in them, a bit of wire bent into a loop is passed through the hole, and a number of the looped bristles being placed in it, the wire is drawn back, bringing the bristles into the hole. The process is repeated until all the holes are filled, when the wire is secured.

For the best tooth-brushes a silver wire is used.

This process is called *drawing the bristles*, and an expert hand can fill five hundred holes an hour, though one hundred is nearer the general average. Where the brush is to be used for acids, or other substances which would tend to corrode the wire, a string is used in its place. Another method of drawing the bristles is to have the back prepared with the holes bored not quite through it, and crossed by other holes bored transversely through the sides; the bristles, being then inserted into the holes, are secured by wires thrust through the transverse holes. These holes are then stopped up by plugs of the same material as the backs, so that frequently they cannot be seen, and the brush appears to be made of a single solid piece.

The delicate brushes for artists are made by taking the delicate hairs from the furs of animals, which are sufficiently soft, and arranging them into a bundle of the proper shape; they are then fastened and run through the larger end of a quill until they project sufficiently beyond the other end. The quill having been soaked beforehand, in order to enlarge it, shrinks sufficiently on drying to hold the brush securely. Brushes of this kind are also often made by being mounted in metallic caps.

Round brushes, for washing bottles and other cylindrical vessels, are made by fastening the bristles, which project upon both sides, between two wires, which are then firmly twisted together.

The chief manufactory of brushes in the United States, and, most probably, the largest single establishment of the kind in the world, is that of E. Clinton & Co., of Philadelphia. In this establishment brushes of every sort and kind are made. The following items from Messrs. Clinton & Co.'s price list will show the variety of the wares they produce: Ground paint brushes of all kinds, wire-bound varnish brushes, sash brushes, plasterers' brushes, nail brushes, painters' dust brushes, kalsomine brushes, hand scrubs, shoe brushes, sweeping brushes, counter dusters, double dusters, window brushes, shaving brushes, crumb brushes,

stencil brushes, flesh brushes, hair brushes, cloth brushes, hat brushes, hearth brushes, horse brushes, tanners' scouring brushes, jewellers' brushes, tooth and nail brushes, artists' badger blenders, flat and round lackering brushes, bear's hair mottlers or spelters, red and black sable brushes for artists, marking brushes, varnish brushes, dusters for gilders, camel's hair tips, graining brushes, bristle poonah brushes, fresco brushes, feather dusters, carriage dusters, picture dusters, &c., &c.

The founder of this well-organized and successful manufactory, which is the only one in the United States doing a general business, and at the same time making a specialty of artists' brushes, is Mr. E. Clinton. He was born on his father's farm, in Massachusetts, and, having migrated to Philadelphia in 1838, commenced working at the brush-making business, at wages of a dollar a week. Having become interested in his business, he resolved upon commencing the manufacture of brushes for himself, despite the obstacle of want of capital which then stood in his way.

His chief dependence for success was in his resolve to introduce new styles of brushes. Having succeeded in making a few brushes of new designs, he managed to sell them to the dealers. As an evidence of the spirit and the motives with which he entered upon his career, and the firm maintenance of which has led to his success, it may be mentioned that some of the brushes he thus commenced with are in use still. They were made so excellently that thirty years of service has not destroyed their value; and, in fact, it would seem that they could never be worn out, with proper usage.

At this time the brushes made in America were poor in quality, as well as in grade; and it was this condition of things which Mr. Clinton sought to revolutionize. Fine brushes at that time were all imported, and the supply was small. Dealers maintained that there was no demand for fine brushes; and it was this mistaken opinion which, Mr. Clinton found, presented one of the chief obstacles to the increase of his business. By steadily persisting, he, however, was enabled to dispose of some fine brushes; and, by economy and hard work, he succeeded finally in saving some two or three hundred dollars, with which, as a capital, he commenced a regular business in Second Street, Philadelphia.

His first step was to secure some one to assist him; and, with the good fortune which is so frequently ascribed to chance, but

which results always from the exercise of good judgment, he obtained the help of a good natural mechanic who has continued with him until this day.

Having met with the success which attends indomitable business energy, when united with conscientious pride in maintaining the excellency of the work produced, Mr. Clinton felt finally able to treat his family to the luxury of a piano. As it was being brought into his store, on Chestnut Street, he overheard one of his workmen saying, "There goes the sweat of our brows." "No, George," he replied; "yours goes down your throat; this is what represents mine."

Such a candid statement of the truth, unaccompanied with any of the pretentious dignity which, founded simply upon pride of purse, fails to recognize the humanity of all those connected with us, regardless of their different social conditions, had its natural effect. The next day "George" took occasion to remark to Mr. Clinton that he was right; and from that day having resolved upon following a different course himself, he has now in his possession a comfortable property which he has saved instead of squandering.

The course of thought and action indicated by this anecdote Mr. Clinton has constantly followed in his relations with those in his employ. Recognizing the rights of labor, he applauds instead of condemning its endeavors to improve its condition; and, feeling that the interests of employers and employed are the same, instead of being antagonistic, he takes an interest in the welfare of his workmen, and has so organized the work in his manufactory, that each workman can make higher wages than elsewhere. There is but little doubt that the unity of purpose thus introduced into all the operations of the firm has been in a great measure the chief cause of the successful career of the enterprise.

The supply of brushes provided by the government for its navy-yards, its forts, workshops and offices, is chiefly obtained from Messrs. Clinton & Co.; and this test of their excellence shows how highly they rank in the market of the world.

In the commencement of his industrial career Mr. Clinton bought imported brushes, of certain kinds, at the rate of two dollars and a quarter the dozen; but in a few years, by the organization of the manufacture, he imported the material, and produced brushes of the same kind which he sold at the rate of nine dollars a gross.

At first it was necessary to import the workmen who were skilled in making brushes of the finest kind; but now that the American workmen have been instructed in the various processes, they have acquired a skill which enables them to make better brushes than the imported ones.

In the organization of this industry it is possible to employ only such workmen as can be relied upon implicitly — who have an industrial conscience and a pride in the result of their labor which will prevent their shirking the details, or doing their work in a slovenly way.

The spirit which Mr. Clinton has carried into the whole business has permeated through the entire establishment and influences every one engaged in it; giving them the collective conscience which makes each of them feel that the reputation of the business is, in ratio to the part he performs, dependent upon himself. Industry thus conceived and carried on resembles more an orchestra than the usual task-work of the world. As in an orchestra, each man is aware that his part is important in the grand result, and that a portion of the credit is his due; and in one case as in the other, the result is harmony instead of discord.

In a business as extensive as that carried on by Messrs. Clinton & Co. the greatest economy can be realized with the best excellence. Engaged as they are in making brushes of every variety and every grade, the material can all be employed to the very best advantage, that which is not suited for one branch being consumed in another. With these objects in view — excellence and cheapness — Messrs. Clinton & Co. will in the future unquestionably maintain the position they have earned as the leading house in the country in the important industry of brushmaking.

CORDAGE.

RUDE ROPES IN ALL AGES AND ALL NATIONS. — INTRODUCTION OF ROPE-MAKING IN AMERICA. — CULTIVATION OF HEMP IN VIRGINIA. — WILD HEMP IN NEW ENGLAND. — INDIAN NETS AND LINES. — CORDAGE MADE BY THE COLONISTS. — MANUFACTURES IN KENTUCKY. — INTRODUCTION OF STEAM POWER. — NEW MACHINES. — PRODUCTION OF EXTENSIVE ESTABLISHMENTS. — ROPE-MAKING BY HAND. — THE MODERN PROCESSES DESCRIBED. — LARGE FACTORIES. — COMPLICATED MACHINERY. — SUPERIORITY OF AMERICAN CORDAGE. — AMERICAN MACHINES ABROAD. — WIRE ROPE. — ADVANTAGES OVER HEMPEN ROPE. — ITS USES.

Cordage is the general term for all kinds of hemp rope, from cables twelve inches in circumference, and weighing more than three thousand pounds in a length of one hundred and twenty fathoms, to a common clothes line, and is especially applied to ship rigging. Rude ropes of some kind — made from bark, wood fibres, vines, leathern thongs, willow, flax, and other materials — have been known in all ages, and among all peoples, for ropes and cords were among the earliest mechanical necessities of man.

The history of the introduction and progress of the manufacture of cordage in America is interesting. It was one of the first industries that engaged the attention of the colonists. Among the occupations laid out in London, in 1620, for the Virginia settlers, special mention is made of the manufacture of cordage from hemp, flax, and "especially silk grass," which was superior for the purpose, and was so esteemed that every family was required to cultivate it. The wild hemp of New England, which the Indians used in making their nets and lines, attracted the attention of the Puritan settlers, who employed it for the same purpose, and in 1629 hemp seed for cultivation was received from England. It was thirty years later, however, before the colonies of Massachusetts and Connecticut took decided steps for raising hemp, especially for cordage for ship rigging, although John Harrison had

made cordage in Boston the year after (1630) hemp was introduced; and John Heyman was "authorized" to make ropes and lines in Charlestown in 1662.

The business spread rapidly through the colonies, and in 1698 there were several extensive rope-walks in Philadelphia. Providence and Newport were early engaged in cordage manufacture, and in 1730 had several manufactories. In 1790 the Maryland ship-yards, at Baltimore, built more vessels than any two other states, and the manufacture of cordage was in proportion. In 1794 Virginia, as well as Maryland, had more rope-walks than any two of the northern and eastern states. A spinning and twisting mill for making cordage was patented in the United States in 1804. In 1808 the Massachusetts manufacturers of twines and lines petitioned Congress for a duty on the imported articles, though then, and for a long time afterwards, much of the hemp and flax worked into cordage came from abroad.

In 1810 the domestic manufacture of cordage of all kinds was claimed to be equal to the home demand; and, besides the manufactories on the Atlantic coast, Kentucky at that time had no less than fifteen rope-walks — at Frankfort, Shelbyville, Louisville, and Lexington. In 1811, though the country was still importing immense quantities of hemp, principally from Russia, the Secretary of the Navy advised an annual appropriation for American hemp for the use of the navy. In 1827 rope factories run by steam were started in Wheeling, Virginia, and at Cincinnati, Louisville, and St. Louis. At the same time there was in use in this country a machine in which the threads on revolving spools passed through perforated iron plates, and then through an iron tube, of different diameters for various sized ropes. In 1834 a new machine was introduced in New York which spun rope-yarn from hemp without the preliminary hatcheling, and saved from eight to ten per cent. of the material. And so, from the earliest manufacture of cordage in this country, rapid progress has been made, — from handwork to horse-power, and then to steam-power, — till the latest inventions and improvements enable large ropes to be made as easily as twine, and a single establishment in three days, or less, can manufacture a complete "gang" of rigging for the largest ship.

Rope-making requires, in connection with the main building or buildings containing the material and machinery, a rope-walk of twelve or thirteen hundred feet in length. By the old process of rope-making by hand, this was literally a "walk," for the work-

man walked from one end to the other and back again. The method was as follows : After the hemp was hackled by means of a steel toothed comb, and sometimes a series of combs, to straighten out the fibres, the spinner wrapped a bundle of hemp about his body, and, drawing out the fibres in front, and twisting them in his hand, which held a woollen cloth to compress the fibres and keep the cord of uniform size, he walked along, making his yarn as he went, the spinning being done by a wheel turned by an assistant, and the spinner seeing that the fibres were equally supplied, and joining the twisted parts at the ends. Two or more spinners might be going down the walk at the same time, and at the end two spinners joined their yarns together, each then beginning a new yarn, and returning on the walk to the end where the second spinner again took his yarn off the "whirl" and joined it to the end of the first spinner's yarn, so that it continued it on the reel. When a sufficient number of yarns were spun, they were wound from one reel to another, passing between the two through hot tar, and were then ready to be twisted into ropes.

This was the process of rope-making up to fifty years ago, and horse-power was employed to twist the strands into ropes. The first machines for twisting the hand-spun yarns into strands and ropes were imported from England; but, in 1834, American ingenuity devised a machine for spinning the yarns, and numerous other inventions, greatly facilitating all the processes which are now wholly conducted by machinery, soon followed.

The modern method of rope-making by the latest improved processes has compelled the erection of large factories, in which the machinery is driven by steam engines of two hundred and fifty horse power, while in some establishments as many as three hundred hands, many of them women, are employed. The hemp is hoisted to the top story, where it is oiled, placed in layers, and then "scutched" by a machine which removes the tow. From the "scutcher" the hemp goes to another cylindrical machine called the "lapper," which extends the fibres and lays the hemp in a long bundle. From the lapper it goes to the "drawing-frame," in which, by a series of rollers, the hemp is drawn into a "sliver" (of the size for the particular work required), which goes with other slivers to a second drawing-frame, and from thence by a conductor to the floor below to the spinning-frames. There may be a hundred or more of these frames on one floor, with two girls to every five frames to see that the sliver is regularly supplied

and the filled bobbins are replaced. By this machinery each full set, consisting of one scutcher, one lapper, two drawing-machines, five spinning-frames, attended by three men and six girls, ought to give twelve hundred and fifty pounds of yarn in a day's work, and the daily product of a factory is in this proportion, according to the number of "sets" and hands.

The next process (if for tarred ropes) is to pass the yarns through a trough of tar at the temperature of boiling water, the yarns passing through holes in a plate, thus removing the superfluous tar. The yarns are then twisted by machinery into strands, the machine running on rails the whole length of the walk. The machines for twisting the strands into ropes of various sizes are ingenious and complicated, and for full explanations require diagrams. The final process is coiling and tying in readiness for the ship or warehouse. There are machines, also, for making flat or band ropes; and for ropes of all sizes, for all uses, from the smallest to the largest cable-laid and hawser-laid, and of almost any length.

American made cordage has a high reputation, and is largely exported, and American machines have been extensively introduced into Europe. The principal factories in the United States are at Boston, New Bedford, Plymouth, New York, Brooklyn, and Philadelphia; and cotton rope is made at Norwich, Connecticut, and elsewhere. Some of the large establishments make an average of nearly ten tons of hempen and other rope per day.

Wire ropes (see WIRE DRAWING) have been in use in some of the European mines for the past forty years, and the manufacture has been extensively carried on in England since 1838. The advantage over hempen ropes is more strength and durability, with less weight. The wire ropes are made of iron of the best quality, and sometimes of steel, and they can readily be spliced. For certain purposes they are invaluable, and their universal application in ship-rigging, for mines, for suspension bridge cables, for submarine telegraphs, and for other purposes, has led to their extensive manufacture, and to numerous patents and improvements in the processes.

CURTAIN FIXTURES.

THE EARLY NEED FOR CURTAINS. — BIBLICAL DIRECTIONS FOR THEIR MANUFACTURE. — HOW THEY SHOULD BE HUNG. — TACHES, WHAT THEY ARE. — SUBSTITUTES FOR CURTAINS. — MODERN INVENTION APPLIED TO THEIR FIXTURES. — THE PENDULUM FIXTURE. — THE SELF-ADJUSTING FIXTURE. — STATISTICS OF THEIR MANUFACTURE.

THE desire for seclusion, of some sort, was doubtless early felt in the life of man. The questions of decency and indecency, modesty and immodesty, relate principally to the sexual functions and associations of men and women. As soon as the human race had sufficiently progressed from their first step of emergence from a lower order of animal nature (if indeed man was not of special creation as such, as some writers still hold), to conceive of distinctions of modesty and immodesty, it is very probable that something in the character of curtains were invented. It may be, however, that so far as mechanical devices for seclusion were concerned, it was a long time before the race resorted to them. Rocks, clumps of trees, tall grass, thick growing vines, hills, caves, etc., furnished hiding-places where the sexes could meet and conduct their courting, and marry without the obtrusive observation of meddlers. The sweet sense of freedom from the interference of others very likely begat the notion of seclusion in the matter of primordial marriages, for with seclusion only could real freedom in this matter have been realized. In those days the happy device of interfering third parties, magistrates and priests, and a public law, could not have existed. Men and women were, perhaps, purer then than now, and felt no need of consulting the caprices of their neighbors, or of paying fees in order to be allowed to exercise a natural right. But nevertheless it is certain that early in the historic periods the race had carried its love of privacy to such an extent, that the inventive genius was called into requisition, and curtains, or their like, were devised.

The great antiquity of curtain fixtures would seem to be established by the Hebraic Scriptures. The author of "Exodus," the second of a series of works commonly known as the "Pentateuch" (a name derived from the Greek words *pente,* five, and *tenchos,* tool or instrument, or, by metonymy, a book), and usually made a part of the "Old Testament" Scriptures of the Christian theologians, recording the specifications made by the Lord to Moses, and by him transmitted to the people, for the manufacture of tabernacles, writes in the 26th chapter of the work referred to: —

"Moreover, thou shalt make the tabernacle with ten curtains of fine twined linen, and blue, and purple, and scarlet; with cherubims of cunning work shalt thou make them.

"The length of one curtain shall be eight and twenty cubits, and the breadth of one curtain four cubits; and every one of the curtains shall have one measure.

"The five curtains shall be coupled together one to another; and other five curtains shall be coupled one to another.

"And thou shalt make loops of blue upon the edge of the one curtain from the selvedge in the coupling; and likewise shalt thou make in the uttermost edge of another curtain, in the coupling of the second.

"Fifty loops shalt thou make in the one curtain, and fifty loops shalt thou make in the edge of the curtain that is in the coupling of the second; that the loops may take hold one of another.

"And thou shalt make fifty taches of gold, and couple the curtains together with the taches; and it shall be one tabernacle.

"And thou shalt make curtains of goat's hair to be a covering upon the tabernacle; eleven curtains shalt thou make.

"The length of one curtain shall be thirty cubits, and the breadth of one curtain four cubits; and the eleven curtains shall be all of one measure.

"And thou shalt couple five curtains by themselves, and six curtains by themselves, and shalt double the sixth curtain in the fore front of the tabernacle.

"And thou shalt make fifty loops on the edge of the one curtain that is outmost in the coupling, and fifty loops in the edge of the curtain which coupleth the second.

"And thou shalt make fifty taches of brass, and put the taches into the loops, and couple the tent together, that it may be one."

The "taches" spoken of above were buttons, or knobs, a portion of the curtain fixtures of those times. It is evident from the foregoing that the art of arranging and hanging curtains was quite advanced in the time of the writer of Exodus, if not of Moses, about whom he discourses. Curtain fixtures doubtless existed long before the author quoted wrote, otherwise so much would not have been written in a style which implies much previous knowledge of the curtain-making art. In view of the special honor which has been rendered to this art, by its being treated or regarded as having been worthy of divine attention, in the manner set forth in the work from which we take the directions cited, the curtain-makers of to-day, and the curtain-fixture makers as well, might be pardoned if they were to consider their art a very select one, possessing perhaps aristocratic or hierarchic claims to consideration.

Further on in the chapter (v. 32) we find that gold rings constituted a portion of the curtain fixtures. The whole work, according to the description therein given, must have been very neat, and at the same time gorgeous, evincing a very far progressed civilization at that time, and which must have had, as its precursors, many thousand years of human development. The elaborate construction of the curtains could have only been the outgrowth of the mechanical inventions and struggles of many ages, and the metal work which they used for the curtain fixtures probably required for its development still many more ages.

At that early day mankind dwelt mostly in tents, and their curtains were appropriate, or practical and convenient, as the race was divided into wandering tribes. They could easily take down and transport their tents and their appurtenances as occasion required. In more modern times communities have become more fixed, so that permanent dwellings are required, furnished with windows to admit light within, and to permit looking out therethrough. Many substitutes have been used from time to time in place of expensive and elaborate curtains of old, among which we may mention those made of rushes, then shavings of wood, light strips of board, muslin, paper, etc., with many contrivances to fasten them in place. The most common method has been to affix the curtain or shade to a roll or stick, and roll it up to the desired height and secure it with a string, dependent from the top, or by means of an endless cord running over a pulley at the end of the sticks, or else by weights to balance the curtain and retain

it in the desired position, so as to obscure or obstruct the whole, a part, or more of the view. These methods are more or less objectionable, very liable to get out of order, and thus cause continual trouble and annoyance.

Many attempts have been made to remedy the defects of the methods we have spoken of above, some of which attempts were in a degree successful, but in some respects lacking perfection. Some twenty years since, Mr. S. S. Putnam, of Boston, invented and patented what is known in the market as the "self-adjusting" curtain fixture, which is so simple and neat a device of mechanics, that we have thought it worthy of representation to our readers.

This retains the shade or curtain in any desired position; never gets out of order; is easily put up without the aid of much mechanical ingenuity, and is furnished to the public at a very moderate expense; thus achieving what is ever the most desirable end of all mechanical contrivances, namely, simplicity, reliability, and cheapness.

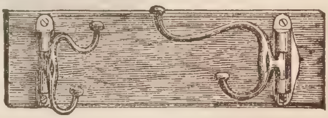
By means of a spiral spring inserted in the end of the roll, which comes in contact with a loose wooden pin upon which the roll revolves, and is retained in its place by the cap or spool, a pressure is obtained, which, acting against each bracket at the separate ends, causes a friction, which is sufficient to hold the curtain at any desired height. By pulling the cord which is attached to the spool the curtain is drawn or rolled up; and by drawing the curtain down, the cord is wound on the spool, thus always being in readiness for use. The extensive demand for this curtain fixture, is but a merited compliment to its success as a mechanical contrivance.

In addition to this, Mr. Putnam has invented, and secured by letters patent, an important improvement, whereby the curtain or shade is attached to the roll without the use of either tacks or screws. This improvement is simply the cutting in the roll of a groove about three-fourths of an inch square, and fitting into it a movable bar of wood. Removing this, and putting the end of the curtain in the groove, and replacing the fastening bar, the curtain or shade is held firmly in its place in the most perfect manner. The curtain can be easily removed from the roller when necessary to be cleaned or repaired. So extensively have these fixtures come into use that they can be found in nearly every city or town in the Union, and no doubt the majority of the readers of this article are familiar with them in their own dwellings.

Mr. Putnam has received many letters patent for improvements in curtain fixtures. At the large factory of S. S. Putnam & Co., at Neponset, Massachusetts, now in one of the wards of Boston, many thousand gross are annually made, consuming in their manufacture not less than five hundred thousand feet of pine, fifty thousand feet of birch, thirty thousand feet of bass and maple lumber a year. Thirty tons of metallic castings and some three tons of brass spring wire are also used. The best of lumber, and kiln dried, is required in the manufacture of the curtain fixtures.

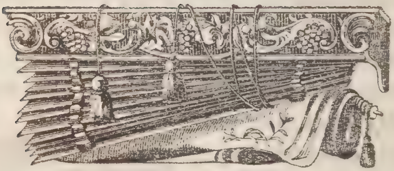
This company also manufacture the perfected pendulum fixture, which is so made that by removing the clutch, by raising the pendulous portion of the fixture, the curtain falls or is unwound by its own weight, and is held in such position as is desired by means of the clutch upon the roll, and is operated by the suspended cord. They also manufacture the balance curtain fixture; in these, weighted or loaded tassels balance the weight of the shade and retain it in any desirable position.

Though not precisely pertinent to this article, yet as a matter of mechanical interest, and the invention of the same Mr. Putnam of whom we have before spoken, we notice a very pretty kind of clothes hooks, which is manufactured by Messrs. S. S. Putnam & Co. The hooks are made to swing on a bracket, so that when not required for use they can be turned aside flush with walls or partitions, and thus be entirely out of the way. They are made of malleable, or very strong iron, and bronzed or silver-coated, and are very neat in appearance. The hooks are mounted on black walnut strips, about three feet in length, with screw eyes therein, so that they can be readily hung up or taken down, without inconvenience or injury to the wall or partition. This, though a recent invention, is rapidly attracting public attention, the demand for it being very considerable already; thus showing that a really good article, however simple, may grow into vast proportions as a matter of manufacture, and become one of the great industries of a country. The engraving represents the simple design of the clothes hooks.



Mr. S. S. Putnam was born in Hartford, Washington County, New York. At an early age he entered the store of a jeweller and watchmaker in Syracuse, as clerk, where he remained some four years. This situation developed the natural mechanical turn

of his mind; for, without any particular instructions from his employer, he was in a short time able to do the repairing of the most delicate watches. Finding this employment too confining for his health he left, and went to Boston, where he entered a dry goods store in the year 1843. Whilst in this situation his attention was drawn to the operation of an upholsterer in putting up window shades, and the difficulty he had to secure the shade to the roll to make it run true. This led him to think upon the subject, and in a short time he invented and patented his celebrated self-adjusting curtain fixture. Seeing in this a prospect to build up a large and profitable business, he quit the dry goods business and commenced the manufacture of these fixtures, which have obtained a very extensive reputation. Some idea of the magnitude this business has obtained, may be had when it is understood that the quantity of brass wire annually consumed, and which forms the small spring in the end of the fixture, if laid in line would reach a distance of 3300 miles; or the rollers, if laid in one continuous line, would reach half around the globe.



HORSE SHOE NAILS.

HORSE SHOES. — THEIR IMPORTANCE. — THEIR HISTORY. — EVIDENCE CONCERNING THEIR USE BY THE ANCIENTS. — FIRST MENTION OF, IN MODERN TIMES. — USE AS A CHARM. — MADE BY MACHINERY. — HORSE-SHOE NAILS. — MADE BY HAND. — MACHINE FOR MAKING THEM. — ITS SUCCESS. — THEIR USE IN THE LATE CIVIL WAR. — THE WORKS FOR THEIR MANUFACTURE.

The vast importance of the iron protections, or shoes for the feet of working horses and cattle, is obvious to every one, and doubtless the necessity that the means by which the shoes are held to the feet be reliable, in order that shoes may be made most useful, is equally obvious. Perhaps in regard to no one simple means or power in mechanics has more study been expended, or more experiments been made, than concerning the horse-shoe nail. When the horse shoe was first invented history leaves wholly in obscurity. We find no intimation anywhere that the ancient Greeks or Romans were in the practice of shoeing horses, or otherwise protecting their hoofs by any mechanical means. Indeed, when the hoofs of war-horses had become broken, we learn that they were allowed to rest; sent out to pasture until the injured hoofs could grow and become sound again. The feet of camels were sometimes encased in a sort of leathern shoe, and the feet of oxen were sometimes protected, or dressed, when injured, by bandages made of the fibres of plants woven together. Suetonius tells us, in his Life of the Emperor Nero, that the latter, on some of his journeys, but not long ones, was drawn by mules, the feet of which were provided with silver shoes; indeed, some of them with golden ones. But these were probably simply ornamental bands around the hoof, and not intended as protections to the feet.

Many have contended that passages in Homer prove that the art of shoeing horses was in practical use in his day, but others declare that the phrases supposed to indicate this are metaphorical.

George Fleming, an English veterinary surgeon, has issued a volume, in which all the evidences on the subject, from Xenophon down, are carefully collected and collated, so as to clearly exhibit both sides of the question. He makes it clear that the daring experiment of driving a nail into a horse's hoof was not ventured upon in classic times.

There is no doubt, however, that different coverings were in use from a remote period, both in Greece and in Italy, to protect the hoof when sore from travel, or when passing over rough roads; but there is much negative evidence that these were never very generally adopted, and that they were awkward and clumsy in construction, and were only used from sheer necessity upon hard and stony ground, or in cases of foot-soreness. When we read that Poppæa or Commodus shod their horses with gold, it is evident that this must mean (as we have intimated above in the case of Nero), that some sort of gilt sandal or sock was drawn over or fastened to the hoof, plated, perhaps, with metal in the sole.

At Pompei, Roman stables have been excavated, and in them have been discovered the bones of horses, and the very ring-bolts to which they were tied, but nothing like an iron shoe. There is nothing in ancient literature or relics to prove that iron plates were nailed to the hoofs of horses in Greece or Italy at any period before the fall of the Western Empire. The first mention of "iron shoes and their nails" occurs in the "Tacita" of the Emperor Leo VI., where they are set down as among the articles requisite in the equipments of a cavalry soldier. Leo VI. was reigning A. D. 900; and though horse shoes were doubtless in use before that time, this is the first known mention made of them. From the remains discovered in tumuli, it has been well established that the Celtic nations used metal horse shoes, fastened with nails, at a much earlier date, which has been variously conjectured to have been at, or as some suppose, before the Christian era.

It is supposed by some writers that horse shoeing was introduced into England by William the Conqueror. Henry de Ferrers, who accompanied him (and whose name is supposed to indicate the fact), held the office of inspector of farriers to William. Six horse shoes were displayed upon his coat of arms. Something mysterious was supposed, at a very early age in the history of horse shoes, to attach to them, and they have consequently been, at different periods, more or less objects of superstition. They have been considered among the lower classes in England, and in

this country in early times, and, indeed, it may be said by many of the higher classes, as protections to houses against "witches" when nailed upon the jambs of doors, preventing the poor witches passing in. It is said that in the latter half of the seventeenth century nearly all the houses in the west end of London were thus protected.

Horse shoes have, since their invention, ever been made by hand, until 1835, when Henry Burden, of Troy, N. Y., invented a machine for making horse shoes, which from time to time he improved upon. As was the case with horse shoes, so with the nails for fastening them to the hoofs. They have always been, until of late, made by hand, being forged out on the anvil by blacksmiths. In many parts of Europe whole villages are devoted to this branch of business. A bundle of rods of iron is received from the chief manufacturer by the head of a family, who takes it to his home, and with the assistance of his wife and children makes it into nails, the product being returned to the capitalist generally after a depreciation of the stock in weight of about twenty-five per cent. for waste. For many years these nails found a ready market in this country, under various brands or marks, such as the "G" or "A" horse nails, as they could be imported at a much less cost or expense than that at which our own blacksmiths could make them.

But the busy, inventive genius of the country was constantly endeavoring to discover some mechanical mode by which horse nails could be cheapened in price, and the number of machines by which the whole nail, or a portion of it, could be made, which have from time to time been set in operation, is not inconsiderable. The great desideratum, namely, a machine by which not only the actual labor could be performed and the nails made, but by which they could be rapidly made, was not reached at once. The evolution of the desired machine from the teeming brains of inventors, guiding the hands in the construction thereof, was slow; a growth step by step, rather than an independent, or novel and perfect invention or discovery as a whole.

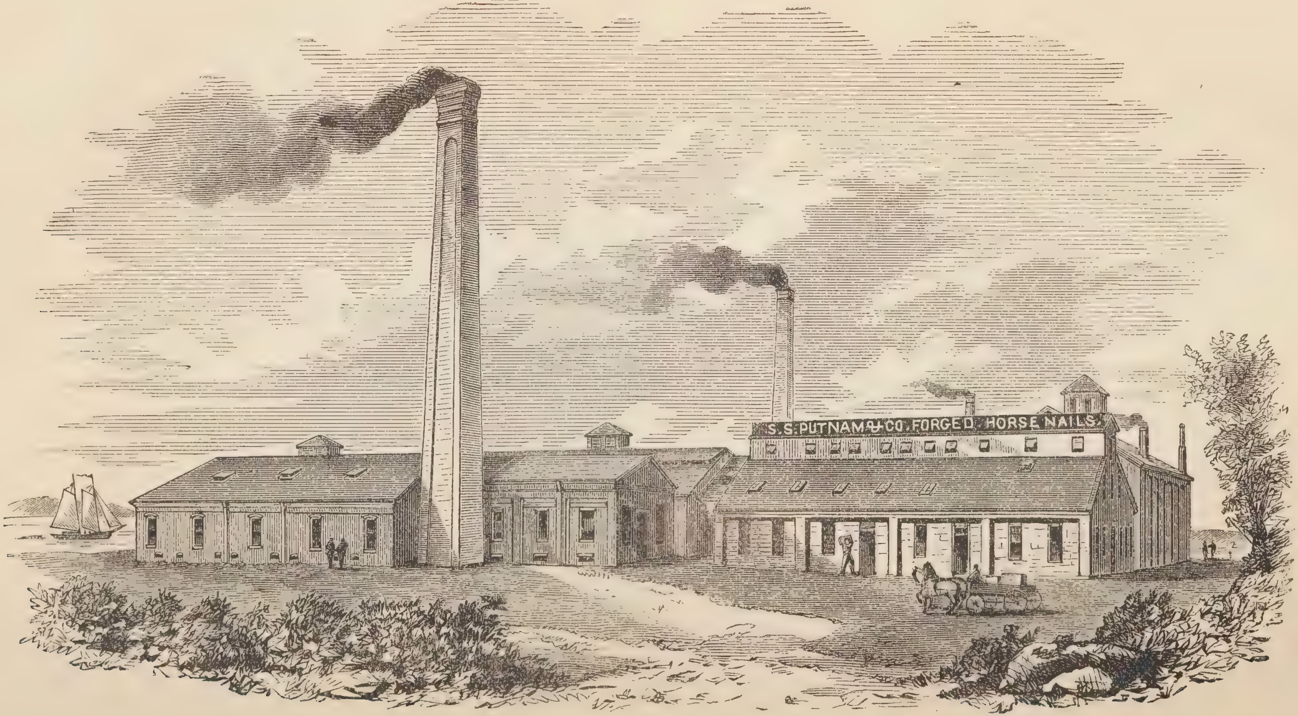
Of late years much attention and large amounts of capital have been devoted in this country to the manufacture of horse nails by machinery, and various methods and devices tried to produce nails equally as good as those made by hand. Good serviceable horse nails require to be made of a very tough, stiff, strong article of iron, and free from flaws of the slightest kind, for in driving them

into the horse's hoof, which is less than one-half of an inch in thickness, it is of the utmost importance that no sliver or splinter shall be formed from them and be driven into the "quick," or tender portion of the foot, whereby the horse would be lamed, or perhaps ruined. No kinds of iron have yet been found to possess the proper qualities for nails uniformly equal to the Norway and Swedish, for which reason these are the most generally used.

Machines have from time to time been made to cut or punch the nail from sheets or plates of iron rolled to a proper thickness, either hot or cold; but it has been found impossible to produce a nail as compact, firm, tough, and strong as can be made by hammering it out on the anvil, whereby the grain of the iron is compacted, refined, and made more ductile and tenacious; and though many nails so cut or punched out have gotten into use, yet the best order of smiths refuse to use them.

In the year 1850 Mr. Silas S. Putnam, of Neponset, Mass., conceived the plan of forging horse nails by machinery from the red-hot rod, in a manner similar to that of the blacksmith; and devoted much time, money, and severe thinking in projecting and perfecting a machine which would make nails equal, if not superior, to those made by hand. After several unsuccessful attempts, each of which lacked some small item of perfection, he at last constructed a working machine capable of making a nearer perfect nail than is possible to be made by hand, and possessing all the desirable qualities of the very best hand-made nail, at a much less cost.

So great, however, was the prejudice among smiths generally against any machine-made nail, that in many cases they refused to use Mr. Putnam's nails, even when given to them without charge. The experience which nearly every inventor of a matter of real merit undergoes, was suffered by Mr. Putnam. It is a strange fact, that a meritorious invention usually enjoys less early success than one of no great importance, and must work its way into public adoption or approval by slow stages, and through many trials. Before it becomes well established in the public's esteem as a staple article of the popular market, a dozen novelties, invented at the same time with, or after it, and of a comparatively worthless nature, may have enjoyed a heyday of success, bringing to their inventors' pockets considerable sums of money, sometimes fortunes, and have gone into oblivion, never to be heard of again. In the order of human, real progress, only the substantial, worthful things survive the tests of time and use.



S. S. PUTNAM & CO.'S WORKS, NEPONSET, MASS.

By dint of constant perseverance and energy, however, these nails were brought into public notice, and at last their superior excellence commanded for them due recognition, and they are now in use in all sections of the United States.

At the commencement of the late civil war, the Boston Light Artillery, before leaving for the seat of war, supplied themselves with "Putnam's Horse Nails," and when they were stationed at Baltimore, the superiority of these nails, in finish and quality over others, attracted the attention of the government officials, who brought them to the notice of the quartermaster-general of the army. The severe tests to which the nails were subjected, and the complete satisfaction which they gave, commanded that officer's indorsement of them, and caused their adoption into general use by the army, as the "Government Standard Horse Nail." Many hundred tons of them were used by our cavalry and artillery forces in all sections of the country.

On the occasion of the defeat of General Pope in Virginia, the rebels succeeded in capturing a government train of quartermaster's stores, among which were several hundred boxes of these nails. These were taken to Richmond, and were considered one of the most valuable articles of the capture, as the South was greatly deficient in horse nails, being obliged to use many of their horses unshod. In fact, had it not been for the horse nails thus captured from our train, the Southern cavalry would have been a weak instead of a strong ally to the Confederate forces.

Some few years since, finding more room necessary for carrying on this rapidly increasing business according to its demands, Mr. Putnam purchased a tract of land lying on the Neponset River, and now embraced in the sixteenth ward of Boston, where the extensive works of S. S. Putnam & Co. are now located. These works use a two hundred horse power Corless engine to drive their machinery, and employ some two hundred operatives in making these now staple articles in the market, known as the "Putnam Forged Horse Nails." From small beginnings, they have increased their yearly consumption to about one thousand tons of Norway iron, using in their manufacture a thousand tons of coal. Eighty thousand boxes are required annually for packing these horse nails for market.

In making a horse-shoe nail by hand the blacksmith gives some twenty blows with the hammer in order to form the same into shape, and can make but from ten to twelve pounds as a day's

work ; but with the Putnam machine the nail receives some sixty blows from the hammer, leaving the iron much more compacted in fibre, and more nearly perfect than is possible to be done by hand, while from one hundred to one hundred and fifty pounds are made daily by a machine.

Mr. Putnam has obtained several letters patent for improvements on his machines, and is still constantly making new improvements upon the machines, whereby the manufacture of the nails is simplified and the expenses lessened. The company use only machines of Mr. Putnam's invention, the first of which was put in operation in 1859. The influence of this advanced step in mechanics, — the making by machinery of a better article of nails than was formerly made by hand, or by manufacture, in its proper signification, — must yet be very great on all sorts of handicraft, as it suggestively leads to the invention of machinery for the purpose of accomplishing other ends in the constructive arts, which it has heretofore been thought impossible to accomplish except by actual manipulation, with certainty of reaching the desirable perfection. Of course the machinery which secures the ends attained by that of the Putnam & Co. can be made to perform like work in other branches of art than nail-making, and will work valuable revolutions in the manufacturing arts and industries of the country.

PETROLEUM.

WHERE PETROLEUM IS FOUND. — KNOWN TWO THOUSAND YEARS AGO. — THE WELLS OF BURMAH. — SOURCE OF PETROLEUM. — DIFFERENCE IN SAMPLES. — SUPPLIES IN THE UNITED STATES. — HOW THE INDIANS USED THE OIL. — ITS USE IN SURGERY. — THE FIRST DISCOVERIES IN OHIO. — BORING WELLS IN PENNSYLVANIA. — BREAKING OUT OF THE OIL FEVER. — ADVENTURERS, CAPITALISTS, EXPLORERS, AND SPECULATORS. — FORTUNES MADE IN A DAY. — FORTUNATE FARMERS. — GROWTH OF THE OIL BUSINESS. — DEVELOPMENT OF NEW INDUSTRIES. — OTHER KINDS OF BUSINESS BENEFITED. — PROCESS OF SINKING WELLS. — YIELD. — SUPPLY UNLIMITED. — REFINING PROCESS. — USES FOR PETROLEUM. — EXPORT.

PETROLEUM, as the name indicates, is a rock oil, which exudes from the earth, or is pumped from wells or bores of different depths. It is found in many parts of the world. It was known more than two thousand years ago to the Greeks and Romans. For centuries the springs and wells of the Rangoon district on the Irrawaddy have supplied the entire Burman empire and portions of India; Bakoo, in Georgia, on the west shore of the Caspian, supplies Persia with the means of artificial light; for more than two hundred years Parma and Modena have furnished petroleum for Italy; it is found in the island of Trinidad; Cuba produces it; it is seen floating on the water in the vicinity of volcanoes; near Vesuvius a petroleum spring comes up through the sea; and new discoveries are constantly occurring in different parts of the world.

What petroleum — which is known also in trade as naphtha, saxoline, cazeline, and by many more names — really is, and from what it is derived, is a matter of dispute. By some it is believed to be of animal origin, and that vast deposits of once existing marine animals have been converted by heat and pressure, as coal beds are formed, into petroleum. Analysis shows that the rock-oil is nearly identical with the fluids distilled from bituminous coal. Samples from different regions show different constituents, or dif-

ferent proportions of the same constituents. The Burmese oil affords about eleven per cent. of paraffine, which has been successfully employed in England in the manufacture of candles. Other samples contain neither paraffine nor benzole; various oils differ also in density; but an ordinary sample will give fifty per cent. of burning oil, and twenty-two per cent of lubricating oil.

In the United States, petroleum is found in great profusion in North-western Pennsylvania, in New York, in Ohio, in Virginia, in Kentucky, and to some extent in Louisiana, in Utah, and in other sections of the country. The oil near the head of the Genesee River, in New York, and that of Venango County, in Pennsylvania, was known from a remote period to the Indians, who used it for medical purposes, and who called the attention of the whites to it more than a century ago. Under the names of "Genesee oil" and "Seneca oil," it was for a long time, and still is, in some sections, a popular and efficacious remedy for rheumatism; and petroleum is now employed in washing wounds, and its curative properties are highly commended. But for a long time after petroleum was known to the people of Pennsylvania, Ohio, Virginia, and New York, there was no thought of it in connection with the many uses to which it is now applied.

In sinking wells for salt water in Ohio, in 1819, petroleum exuded in such quantities that, according to an article in the *American Journal of Science,* in 1826, it began to be in demand for illuminating purposes, and was used to a considerable extent in factories and workshops. Oil Creek, in Venango County, Pennsylvania, — the most prolific source of petroleum supply in the country, — was so named by the earliest settlers; but it was not until 1845 that any attempt was made to procure the oil in quantities, and what was produced was used almost wholly for medical purposes. Yet in this region there are remains of old oil pits, which may have been dug by the French early in the last century, or by the Indians, showing that supplies beyond what oozed from the ground or floated on the streams were sought for. That it existed in any quantity, or that there might be regular and easily controlled sources of supply, does not seem to have been imagined till 1845, when a bore for a salt well, twenty-five miles distant from Pittsburg, developed two oil springs that yielded a barrel in twenty-four hours.

This was the beginning of the "oil fever." Nine years later companies were formed in New York; land and rights were pur-

chased, and experiments were made in the purification of the oil. In 1859 a New Haven company bored a well at Titusville, on Oil Creek, which, by pumping, gave a thousand gallons of oil a day. Soon after, wells of from five hundred to six hundred feet in depth flowed at the rate of three thousand barrels a day from each well. An immense excitement was the natural consequence. Adventurers, capitalists, explorers, and speculators flocked to the oil region of Pennsylvania; farms and rights were sold at fabulous prices; a few farmers, who were the fortunate possessors of well-located lands, suddenly found themselves in receipt of incomes of hundreds of thousands of dollars, and the country went fairly wild over petroleum speculations.

Before the close of 1860 more than two thousand wells were sunk in the vicinity of Oil Creek, seventy-four of which were reported as yielding daily eleven hundred and sixty-five barrels, which, at the then price of twenty cents a gallon, gave ten thousand dollars. Large fortunes were made — and lost — in the business. The trade had its periods of success and depression; but when the business ceased to be speculative, and settled down upon a solid basis, with a large home demand, and an extensive export trade, the production of oil steadily increased, new wells were dug almost daily, and a new and most important source of wealth was added to the industries of the country. Every business in any way connected with the oil received an immediate and immense impulse. The railroads which carried the oil to the cities and to the coast were busy transporting it by night and day. New cars, with very large iron tanks for conveying the crude oil in bulk, were constructed. Oil refineries were started in several cities. Iron founderies found work in casting pipes for the wells. For the pumps there was a large demand for steam engines. And thus, in various pursuits apart from the immediate production of the oil, employment was furnished to thousands of mechanics and laborers.

The process of sinking the wells is quite simple, and is similar to that of boring artesian wells. As the boring descends, iron pipes of ten or twelve feet in length are driven down through the bored earth and rock till oil is "struck." Frequently, when a well is apparently exhausted, or when the flow is feeble, further and more abundant supplies are obtained from the same well by deeper boring. Of course the oil rises by the pressure of water in the springs beneath; and when a well is first opened, very often the flow is profuse and spontaneous, though after a while to nearly

every well a pump must be applied. The yield of wells, even of those which are side by side, differs greatly, and wells sunk in what promised to be the most productive section have been anything but profitable. The best localities, without reference to the precise spot for particular wells, — for this is beyond human ken, — are well known; and so far as discoveries to this year (1871) extend, Pennsylvania, Ohio, and Virginia offer the best oil grounds. The supply of petroleum may reasonably be believed to be inexhaustible.

The process of refining petroleum is the same as that applied to coal oils, and, indeed, most of the establishments formerly employed in the rectification of crude coal oils have, since 1860, been converted into petroleum refineries, which do a large and profitable business. The crude oil, as it comes from the wells, is used for many purposes, and the refined furnishes oil for illumination, lubrication, medical purposes, etc. The general use of petroleum, which has almost taken the place of sperm oil, has also developed a new and remunerative industry in the manufacture of lamps adapted to the fluid, and numerous patents have been taken out in the United States for inventions which make petroleum and its products subservient to domestic purposes in generating heat and light.

It must not be supposed because petroleum has ceased to be an "excitement," or a mere matter of speculation, that its production has been diminished, or that its importance has decreased as an article of foreign and domestic use. The increase in the flow of oil in Pennsylvania since 1867 has been nearly fifty per cent. The export of petroleum in 1860 was only one and one-half million of gallons; in 1868, it was ninety-nine million gallons; in 1870, the export was one hundred and forty-one million gallons.

GAS FIXTURES AND LAMPS.

THE DERIVATION OF OUR WORD LAMP. — THE HISTORY OF APPLIANCES FOR LIGHTING. — LAMPS AMONG THE ANCIENTS. — LAMPS IN ST. PETER'S. — GAS. — THE MANUFACTURE OF GAS FIXTURES. — DESCRIPTION OF THE FACTORY OF MESSRS. CORNELIUS AND SONS. — BIOGRAPHICAL SKETCH OF THE FOUNDER OF THE HOUSE.

Lamp — from the Greek word *lampein,* which signifies *to shine* — is a generic term, which properly includes all sorts of lights and their holders, candlesticks, gas fixtures, and other burners. In close proximity to the axe and the plow, the article of lamps, or holders of the materials from which light is evolved, has place among the artificial necessities of man. The enjoyment of light in the night season could not be realized practically to any great extent without the means of vessels, or other mechanical devices of some sort, to contain in place, or convey to the action of heat, the fuels, oils, gases, etc., from which light is drawn. We have no historic account of any article of utility or ornament of a more remote antiquity than the lamp. Fire-worship would seem, from all we can gather from the meagre intimations of history, to have been one of the earliest, if not the earliest, of cults, — sun-worship, perhaps, preceded it, — and probably led to the lamp or candlestick being regarded with something like reverence in the early historic period.

Lamps of varied and beautiful shapes have been found among the ruins of Pompei and Herculaneum. The Museo Borbonico at Naples, is rich in relics of beautiful works, among which are lamps in great numbers, taken from these ruins. According to the legends of the Chinese, their ancestors far back, thousands of years beyond the dawn of the historic period of the Western nations, must have been familiar with the lamp. But we need not dwell further upon its remote antiquity. Some of the ancients, we are told, endeavored to make a lamp which should burn per-

petually; which should need no replenishing with oil. Strange as must have seemed to their contemporaries, the hallucinations of these ambitious inventors, something akin to the eternal-burner which they sought, is now found in the "gas fixture," or metal tube of to-day, and its contents of bi-carbureted hydrogen. Had the gas fixtures of to-day been invented in antique times, we can probably hardly conceive to what power they would have been ascribed, for our modern illuminating gas supposes a deeper acquaintance with science than all the magicians and philosophers of antiquity together possessed. In St. Peter's Church at Rome, as well as in many other Roman Catholic cathedrals and churches throughout the world, lamps are kept constantly burning. The custom is supposed to be of early origin, and to have been borrowed from a still earlier one, the object of which was, among the superstitious, to keep off evil spirits, who, it was thought, could only flourish or do harm to man in the dark. But the enlightenment of modern times demonstrates that the most evil spirits among men may walk abroad at noonday, and do their nefarious work in the full light of the sun, to say nothing of gas-light.

The manufacture of gas fixtures is of modern date, and has become one of the most important industries of the day, considering both the utilities it serves and the sense or love of beauty to which it administers. A few years ago the majority of gas fixtures used throughout the world were manufactured in Europe, principally in England and France, and chiefly by small manufacturers. To-day a single firm or establishment in this country, that of the Messrs. Cornelius and Sons, of Philadelphia, Penn., makes nearly one-half of all the gas fixtures manufactured in the United States, which, together with the unsurpassed, if not wholly unequalled character as well, of their wares, renders them the representative manufacturers in their line. There are several other manufacturers of gas fixtures in the United States, who make good wares, both as to quality of workmanship and the ornamental character of their designs, but it would be almost impossible, if not quite so, to exercise more care and study in manufacture and ornamental designs than are observed by the Messrs. Cornelius in the manufacture of their goods.

In treating of the great industries of the country, it is a matter of extreme satisfaction to the writer, as interested in both the per-

fection of a specific ware, and the bearing it has upon the weal of the nation, to be able to find among the manufacturers thereof men whose pride in the accomplishment of perfect work, for sake of the pleasure of making it, seems to be at least equal to their ambition in money-making. The Messrs. Cornelius would seem to be so circumstanced, that however inclined they might be to slight their work for money-making purposes, they cannot willingly do so on the score of honor. Having a reputation for making perfect wares, upon which their vast establishment has been built up, they have a peculiar pride in sustaining it. In the writer's large acquaintance with the modes of manufacture, he knows of no establishment for the production of any ware in which the processes of work are more systematized and nearer perfect that in that of the Messrs. Cornelius' Gas Fixture Manufactory.

The extent and importance of the manufacture of gas fixtures in this country will be apparent on reflecting that in nearly all the houses of the great cities, and in nearly every village having a population of four or five thousand, they are now in use. There are a great number of isolated residences in the country, the owners of which manufacture their own gas by private methods, and whose houses require the gas fixtures. The demand for these wares is increasing every day. In order to acquaint himself with the mode of manufacturing the gas fixtures, the writer recently paid a visit to the establishment of Messrs. Cornelius among others. All the processes pursued in other manufactories, and which are of any worth, are to be found in operation in this establishment, besides many improvements secured by letters patent, and which are not to be found elsewhere. A description therefore of what is to be seen at this establishment will cover the whole subject for the general reader.

Messrs. Cornelius & Sons' principal establishment is situated on Cherry Street, in the city of Philadelphia, and is also in business communication with another large establishment of theirs on the corner of Columbia Avenue and Fifth Street, in the same city. The Cherry Street building is an immense structure, some four hundred feet in length of its façade, and vast wings, and is five stories in height. It is built entirely of brick and iron, is in the form of a hollow square, and fire-proof throughout. As a building for its purposes it is a model of convenience, and is divided into some eighteen separate and distinct departments, or work rooms, all well lighted, thoroughly ventilated, and heated

by steam. It is, without doubt, one of the most perfectly organized establishments in the United States.

Entering the establishment, the visitor proceeds, perhaps, first to the modelling rooms. The firm have in their employ several designers or artists who occupy separate rooms, in different parts of the building, and who do not intercommunicate, each depending upon his own unaided genius in devising sketches for the models. Thus greater originality of design is accomplished. Following a design which is given him, sketched upon paper, the modeller proceeds to mould into required shape a mass of prepared wax. After the design is "roughed out," he consummates his task with the aid of tools made of hard wood or steel. When the pattern, frequently the work of weeks, is completed, it goes in the hands of the "caster," who makes a mould of it in brass, which is sent to the "chaser," and is elaborated into a standard pattern, from which the caster may multiply an infinitude of copies. It is a very nice operation to make a mould from the original wax pattern, the fragile material rendering it necessary to use every precaution in obtaining a brazen fac-simile of the original. Much depends upon the "chaser." When the first brazen copy of the pattern is placed in his hands, the embellishments on its surface are faint, and require to be deepened. The partially developed fibres and veins of leaves and flowers, the feathers of birds and fur of animals, are by him made distinct. He uses small steel chisels, of various shapes, with which the necessary indentations are made by sharp blows of a light hammer. The completed pattern is returned to the caster. In casting a drooping feather or a crumpled vine leaf, for instance, it is found more expeditious to flatten the pattern. After the casting is finished, the proper curves are given to the hitherto flat surfaces by means of wooden mallets and other tools.

In the casting-rooms, where many men are employed, the heat from the furnaces is very great, and becomes almost stifling, in conjunction with the sulphurous fumes of the liquid mass of mingled copper and spelter, forming brass, which is glowing and seething in black-lead crucibles placed in the midst of fiery anthracite. Each caster works at a wooden trough, into which he carefully sifts prepared sand, slightly moistened. This sand is of a kind peculiarly fitted for moulding, and found in the region of Philadelphia. Thus prepared the sand is placed in flasks, and the process of moulding, sufficiently understood by general readers, is

proceeded with. After the crucibles have been emptied into the moulds a few minutes suffice for the lately molten brass to chill into a hardness which permits the flasks to be opened, by removing the clamps, when it is a matter of surprise to note how faithfully the finest chased work has been transferred from the original pattern to the copy.

The castings are conveyed from the foundery to the filing department. Here scores of files create a constant din, not musical to all ears. The castings are first "edged up" with course rasps, and then finished with finer tools. In many instances a number of castings must be joined to form one piece. The several parts are conveyed to the soldering room, where they are properly fitted together, care being taken to leave one edge more prominent than the other. The sections are then put into their proper places, and retained in position by iron wire. Particles of brass solder, which look like brazen saw dust, are wet with water and carefully applied along the projecting edge of the section. The entire piece is then placed in a furnace, where the solder is melted. The work then undergoes another filing. The joints must be made with the utmost care, for the subtle gas would escape through any tiny opening left in the work. Before the castings leave the filing and soldering rooms, there is frequently much to be done in the way of the twisting of branches, crumpling of leaves, drilling of holes, etc., etc.

The castings are taken after the re-filing, etc., to the dipping room. Here everything is done by means of chemical agents. The room is a perfect laboratory in itself. There are ranges of monstrous stone jars filled with divers colored acids, of different degrees of strength; pans and kettles filled with various liquids; and hot, lukewarm, and cold water is flowing in abundance. When the castings leave the hands of the filers they are dirty and discolored, and more or less sand or other foreign matter clings to them. The first act of the dipper is the taking up of a casting with a pair of tongs, and dipping it into a jar of acid. Only a moment is required to remove by this process every particle of dirt from the surface of the piece. The chemical would soon devour the piece itself if sufficient time were given it. But the dipper speedily takes out the cleansed metal and places it in water, which arrests the ravages of the acid.

This operation of plunging the metal into acid is called "pickling." The color of the metal is rendered by it essentially brass-

like, as the "pickle" has devoured the foreign substances on its surface. The article thus cleaned is then dipped into a jar, the contents of which are a mystery to us. This has the effect to give the surface a rich sulphur color. This operation occupies but a moment. The piece of metal is again washed in clean water, and is then plunged into a chemical combination called an "ormolu;" in a few minutes the color of the metal is changed to a dirty yellow. The ormolu is then washed off, and the surface of the metal is found to have been eaten into minute molecules. One more dip into an acid, which gives the brass a rich, pale gold color, finishes the chemical ordeal. After the piece is again cleansed in water, it presents a rich and uniform, though dull gold color. This dulness forms a good foil, and contrasts finely with the prominent parts of the design, which are afterwards richly burnished, the ormolu having prepared the surface of the metal for that operation.

In an apartment adjoining the dippers is another one in which the coating of the brass which has passed the ormolu process is carried on. The galvanic battery is here put in use. The piece of brass is put in connection with the battery, and is made to form the negative pole of the instrument. A bar of pure silver acts as the positive pole. The brass is then held in a solution, and the bar of silver is played around it under the surface for a few seconds, which suffices to precipitate upon the negative pole, or piece, a coat of silver thick enough to bear without injury the action of the burnishing instrument.

Burnishing is an important process in the manufacture of gas fixtures. In the burnishing room of Messrs. Cornelius & Sons, a little army of burnishers is employed. The tools used are of a great variety of shape, and during the process of burnishing are frequently dipped into a dark-colored liquid, which on inquiry we find to be simply small beer. The parts of the surface of the metal which are not burnished are "dead," or "matted," as they come from the ormolu. Much of the beauty and character of the work depends upon a judicious selection of the parts to be burnished. It is, to the proper development of the design, what lights and shades are to a good picture.

The process of lacquering, which is a very important one, is carried on in a room supplied with stoves, which are kept in all seasons constantly heated. Here the various articles are placed upon hot iron after being carefully brushed. When heated to a certain degree, the articles are taken to a table, where the lacquer is

applied with fine, flat brushes. Some articles are dipped into the lacquer, and "slung" backwards and forwards, in order to make it certain that the lacquer is properly spread over their surfaces. The lacquer must be scientifically prepared and skilfully applied to insure a rich and lasting gold color, unaffected by the action of the atmosphere.

The different parts and ornaments after undergoing the processes described are ready to be placed in the hands of the fitter or finisher, and are selected and taken to the respective places for putting them together. One room is occupied entirely by a number of men who are constantly employed in fitting together such gas work as chandeliers, pendants, brackets, etc.; another room is devoted to the numerous class of solar lamps designed for standing upon the table, or to be suspended from the ceiling or against the wall. Some of the ornamental work is painted in party-colors, to please fanciful tastes; some is bronzed in different shades, while other work is covered with a coating of fine gold, or tastefully enamelled.

We have now noted the processes by which blocks of spelter and of copper are converted into articles of use and taste. But many of them to which we have alluded are only the branches or outer flourishes of a grand design. The construction of a chandelier involves much more than we have noted. The main body of a chandelier is a hollow shell of metal, technically called a "bowl." Formerly the making of the bowls was a tedious process. A plate of brass was hammered into shape by hand, and often occupied eight or nine hours for the forming of a bowl. Now, by the improved machinery of Messrs. Cornelius & Sons, one man can turn out several hundred a day. A plate of brass is cut or stamped out in a circular form, a small hole being also cut in its centre. It is then taken to a turning lathe. A block of wood of the desired shape is fixed firmly in the lathe, and the brass plate is secured at its centre to the block. The "spinner" then lubricates the surface of the plate, that his tools may work easily. The lathe is set in motion, and the wooden block, with the brass plate attached, is made to revolve rapidly; and the "spinner," by means of a smooth iron tool, presses the plate over the wooden mould, until it covers it closely in every part. This forms one half of a "bowl." The process is expeditious, but requires both strength and skill in the operator. After being spun, the bowl then undergoes the processes of turning, filing, fitting, dipping,

burnishing, and lacquering, and is ready to form the body or centre of the chandelier, to which the branches, etc., are fastened by means of several vases, and a variety of other articles are spun in the same manner.

There is a vast amount of turning of metals required in the prosecution of this immense business. The drilling machines, tapping machines, and screw cutters, would of themselves form the interesting subject of a long article. One apartment is devoted to the grinding of keys, or faucets of the gas fixtures. This work requires the utmost care, as an aperture almost imperceptible would occasion a serious leak. There are other rooms on which tin and coppersmiths are engaged at their special branches of business. The packing rooms of this establishment reveal the vastness of the business; tons of paper being annually used to wrap the goods for transportation.

The "Pattern Room" is a museum of art. It is large and well stocked, kept under lock and key, and watched with jealous care. Here a copy is preserved of every pattern worthy of being retained made by the proprietors since the commencement of their business. The collection is valued at a high rate. The articles could not be replaced.

The gas fixtures of this establishment are to be found in the majority of dwelling-houses lighted by gas throughout the land, and their lamps are everywhere seen, while nearly every capital in the United States, together with most of the large public buildings and churches in the cities, are lighted with chandeliers made by the Messrs. Cornelius. Their work enjoys no less high reputation for its faithfulness, than for the conscientious manner in which it is constructed throughout. The large corona chandelier for the Columbus Avenue Church, Boston, in Gothic style, gilt relieved with blue and crimson, with a cross pendant, may be cited as an example of the great beauty in form and finish of their work. But it is needless to specify the magnificent works of this establishment. The public favor which, in recognition of the great art, skill of the establishment, and the fair dealings of the high-toned gentlemen who conduct it, has made the establishment the first in importance in the world, is assurance enough that the wares of this house are of the highest character possible to the art.

About five hundred workmen are employed in this vast establishment, and with the splendid improvements in the machinery

which they operate, and the perfect arrangements for combination of labor which the establishment possesses, are able to complete annually an amount of work, which, under the processes that obtained a few years ago, it would require an army of thousands of men to perform.

Christian Cornelius, the founder of the house, was born in Amsterdam, Holland. His father was a mathematical instrument maker, and he learned the trade of a silversmith. He came to this country, landing in Philadelphia, about 1800, where he soon acquired a reputation as a very skilful worker in metal. He soon commenced business upon his own account as a manufacturer of silver plated ware; and having associated with him his son Robert, the present senior partner of the house, the firm, about 1827, added to their specialty the making of lamps and chandeliers. Robert Cornelius was born in 1809, in Philadelphia, and after passing through the schools of that city, commenced to take part in his father's business, going practically through every department of it. At the same time he studied chemistry under Dr. Troost, of Nashville University, and drawing, under James Cox, the artist. The good result of this training was seen in the improvements he suggested in many of the operations of the business, and in the mechanical devices he invented to facilitate many of the processes of manufacture.

In 1831, Robert was admitted to the partnership, under the style Cornelius and Son; and as soon as the use of gas was introduced, the firm began to turn their attention to supplying the necessary appliances for its consumption. Robert Cornelius had also invented and patented a solar lamp, for burning lard or sperm oil, which was largely used; and besides his attention to the increase and perfection of the processes in his own business, his interest in chemical studies led him to experiment with the daguerreotype, when that new art was first suggested, and he was the first who made use of bromine, by which the time needed for taking a picture was reduced from ten minutes to ten seconds. He also experimented with, and improved many of the processes of plating, by electric and galvano-electric methods, and applied the "electrophorus,"—an arrangement by which the gas is lighted by electricity, and which is not affected by the weather, and works only with the simplest movement.

The firm at present consists of Robert Cornelius and his three sons. (Christian, the founder of the house, died in 1851.) The

younger members of the firm have received all the advantages of education and careful scientific training which our modern times afford, and then entering the manufactory, have acquired a thorough, practical knowledge of all the mechanical and chemical processes of the business, and thus are fully able to take part in keeping the organization of their enterprise abreast with the new demands of the time, and the growing love of artistic, as well as other merits. The wisdom of this course is proved by the success which the firm has made, and the universal demand which they have created for their wares.

PIANO–FORTES.

THE PIANO-FORTE CURTLY DEFINED: DERIVATION AND MEANING OF THE NAME. — THE MANUFACTURE OF PIANO-FORTES IN THE UNITED STATES. — STATISTICAL ITEMS. — THE PIANO-FORTE AS A SOCIAL INFLUENCE, AND THALBERG'S ESTIMATE THEREOF. — THE PIANO-FORTE NOT OF SPECIAL INVENTION, BUT A GROWTH. — DR. RIMBAULT QUOTED. — PARTIAL HISTORY OF ITS GROWTH. — THE ANCIENT LYRE, THE HARP, PSALTERY, DULCIMER, CITHERA, CLAVICITHERIUM, AND CLAVICHORD, AND HARPSICHORD PRECEDE IT IN TIME. — SOME OF THESE INSTRUMENTS DESCRIBED. — THE "VIRGINAL" IN QUEEN ELIZABETH'S TIME. — THE SPINET. — BURKHARDT TSCUDI, THE GREAT LONDON MANUFACTURER OF THE EIGHTEENTH CENTURY. — WHO INVENTED THE PIANO-FORTE? — CRISTOFALI, MARIUS, SCROTER. — THE FIRST PIANO IN ENGLAND. — IMPROVEMENTS IN CONSTRUCTION. — SEBASTIAN ERARD. — IRON FRAME INSTRUMENTS. — THE BROADWOOD AND CHICKERING "ACTIONS". CLIMATIC INFLUENCES AFFECT THE INSTRUMENT. — THE REPRESENTATIVE MANUFACTURERS IN AMERICA, MESSRS. CHICKERING & SONS. — MR. JONAS CHICKERING. — THE MESSRS. CHICKERINGS' VAST ESTABLISHMENT AT BOSTON.

THE piano-forte, as contra-distinguished from any other musical instrument, is clearly, if not most felicitously, defined in the language of one not only conversant with its history, but thoroughly understanding its mechanical character and musical powers, as, "simply a harp in a box strung with fine steel strings, operated upon by the hammers of the 'action' through the fingers on the key-board."

The name of the instrument is compounded of two Italian words,—*piano,* which signifies *soft,* and *forte,* which means *strong* (or *loud,*) — a name which this "horizontal harp" has borne, probably, for but little more than a century, it being regarded by some writers as having been first suggested by Christopher Gottlieb Schröter in 1768, when defining what might be accomplished upon the instrument as it then existed, when improved by his inventions; namely, that upon such improved instrument one "might at pleasure play *piano* or *forte.*"

The manufacture of the piano-forte in the United States, as an

article of trade, is of vast importance, both as regards the amount of capital invested, the number of instruments made, and the great number of persons employed directly, and indirectly, in connection with it. The instrument is regarded as almost a household necessity, and probably in no country is the piano-forte more popular than in this. An illustrating instance of its popularity in this country now occurs to the writer's memory, in that some fifteen years ago he saw a splendid "Chickering" piano-forte taken to the house of a Texan planter upon the prairie, a few miles away from Ralston's Ferry, a point of embarkation on the Brazos River, about one hundred and twenty miles inland from the Gulf coast, — the worth of the piano evidently being twice that of the planter's house. And it is probable that the piano-forte cost the planter more than all the rest of his household furniture.

The statistics for the year 1865, show that during that year the piano trade in the United States amounted to fifty-nine millions two hundred and eighty-four thousand six hundred and seventy-three dollars. The number of pianos made that year was one hundred and eighteen thousand two hundred and eighty, and the manufacture is constantly growing in importanee.

The social importance of the piano cannot well be overrated; and its refining influences, in the United States especially, can be fully appreciated by those only whose memory extends back clearly over a period of about thirty years. In fact, the piano-forte may be properly declared to have been the most important single influence which has wrought the social change for the better, so marked among our people within the last thirty years. Mr. Thalberg, the great pianist and composer, in the official report of the jury on Musical Instruments at the "World's Fair," at London, in 1851, expresses the social value of the piano-forte in language not only most worthy of quotation here, but in terms so appropriately descriptive of the instrument's influence in this country in these later years, that one might almost conjecture that Mr. Thalberg possessed a sort of prophet prevision, as well as that he was well versed as to the customs of our people at that time, and had the United States, in her future, in his mind's eye as he wrote. He writes, "The social importance of the piano is, beyond all question, far greater than that of any other instrument of music. One of the most marked changes in the habits of society, as civilization advances, is with the respect to the character of its amusements. Formerly, nearly all such amusements were

away from home, and in public ; now, with the more educated portion of society, the greater part is at home, and within the family circle ; music on the piano contributing the greater portion of it. In the more fashionable circles of cities, private concerts increase year by year, and in them the piano is the principal feature. Many a man engaged in commercial and other active pursuits, finds the chief charm of his drawing-room in the intellectual enjoyment afforded by the piano.

"By the use of the piano, many who never visit the opera or concerts, become thoroughly acquainted with the choicest dramatic and orchestral compositions. This influence is not confined to them, but extends to all classes ; and while considerable towns have often no orchestras, families possess the best possible substitute, making them familiar with the finest compositions. The study of such compositions, and the application necessary for their proper execution, may be, and ought to be made the means of greatly improving the general educational habits and tastes of piano students, and thus exerting an elevating influence in addition to that refined and elegant pleasure which it directly dispenses."

The piano-forte of to-day is not an instrument of special invention. It has grown and progressed during the past three centuries, through different forms and under different names. Dr. Rimbault, in his work published in London, 1860, regards the initial principle of the piano-forte as found in the stretched string of the ancient lyre. But it is obvious that the principle must have been discovered before the time when the lyre obtained its distinct form as such ; for it must have been the fact of sound's being evoked by the string, or some other stretched substance being caused to vibrate against the atmosphere, which first suggested the lyre itself. The writer referred to traces the instrument from the ancient lyre, through various mechanical phases, the harp, psaltery, dulcimer, etc., to the clavicitherium — a name compounded from the Latin *clavis*, a key, and *cithera*, the name of an ancient instrument of music, which consisted of strings drawn over a sounding wooden surface or bottom, and not unlike the modern guitar. The clavicitherium was an oblong box, containing a number of strings arranged in a triangular form, and which were struck by a *plectrum* — a little mallet, commonly made of ivory, with which the ancients beat the strings of the lyre. It is said that the union of the keyboard and stringed instrument was accomplished in the twelfth century. Soon after the clavicitherium

came the clavichord, a keyed instrument, oblong in form, and of the character of the *spinet.* Its strings were covered, to some extent, with cloth, and when struck, vibrated with a sweet, soft tone. It was sometimes called the "dumb spinet." The clavichord held chief sway in popular favor among musical instruments for six hundred years. In the days of Queen Elizabeth an instrument called the *virginal* divided favor in England with the clavichord.

The spinet, which came into use in the sixteenth century, was a triangularly shaped box, having sometimes as many as forty-nine strings, some of them being of steel. The form in which the strings of the present square piano are arranged is obviously a copy of that made by the strings of the spinet.

The harpsichord came into use in the fifteenth century, and was a keyed instrument, resembling somewhat the grand piano. Its sounds were produced by means of "jacks" — oblong pieces of wood, furnished with little *plectra,* made of crow-quill, moved by finger keys over stretched wires. It was furnished with stops, by which the power of the strings was increased or diminished, and a swell. Some of these instruments had a compass of five octaves, from double F below the bass to F in altissimo. The harpsichord gradually took the place of the spinet and virginal, and ruled as the highest form of keyed instrument until the piano usurped its place in the eighteenth century. Of the manufacturers of harpsichords in London in the eighteeth century, the most distingushed was Burckhardt Tscudi, the father-in-law of the more distinguished John Broadwood, one of the earliest of the English makers of pianos, and who established the firm in London which still bears his name.

Of the piano-forte, Dr. Rimbault says, in his able work, "Precisely who invented the piano-forte, — that is, who transformed the harpsichord into the mechanical contrivance which now bears the name piano-forte, — is not precisely known. The inventor's name is obscure, if not wholly lost. But on this head, which has been one of much speculation and discussion, we have not space to go into details." Of the claimants of the invention of the piano-forte, Dr. Rimbault, whom we have cited before, on another point, says, "It was within a few years of each other that, by a remarkable coincidence, three makers (of harpsichords), in three different parts of the world, conceived the idea of the piano-forte. The one was an Italian, the other a Frenchman, and the third a

native of Germany. Marius, the French manufacturer, and Schrötér, the German organist, have hitherto had the advantage of priority of date conceded to them, whilst the claims of Bartholomeo Cristofali, of Padua, have been almost entirely overlooked."

The great improvement made by the invention of the piano-forte, and the particular difference between it and its immediate predecessors, the harpsichord and the spinet, consisted in the substitution of hammers for striking the strings, instead of the jack and crow-quill. The French claim the invention for Marius, a maker of harpsichords, in 1716. The Germans claim the honor of the invention for Christopher Gottlieb Schröter, before mentioned in this article, in 1717. An error has heretofore existed regarding the date of the claim of Cristòfali, in consequence of a statement made by the Count G. R. Carli, in his works, printed in Milan, in 1784–1794 (vol. xiv. p. 405), in which he gives the date as 1718. "The count's error" (says Rimbault), "as to the exact date, has caused much confusion, and led to Cristofali's claims for priority of invention being ignored. The discovery, which the count places in 1718, had been made known to the public in 1711, in the Giornali de Literati d' Italia, Venice, 1711 (tome v. p. 144)," to which, as reproduced by Rimbault, the curious are referred as to the details of description, etc. We have not space herein to present translations of the pertinent parts of it.

The fact is also acknowledged by Dr. Burney, in the Oxford Encyclopædia, Wilkes' Encyclopædia, and the Encyclopædia Brittannica: "It is singular that these three ingenious men, Cristofali, Marius, and Schröter, should have conceived the same idea within a few years of each other, and without any apparent communication or collusion. But the priority of invention is certainly due to the Italian maker, whose claims are now fully established." But great as seems this matter of concurrence of inventive thoughts, — a fact which no farther back than the middle ages would have been regarded, doubtless, as an absolute evidence of special divine inspiration, and would have given the blessed inventors each a place in the calendar of saints, — it is not so strange after all, as the records of applications for letters patent to our government, and that of England and France, plainly show. Not only in the same year is it, as it appears, that persons, separated by hundreds of miles from each other, strangers without "communication or collusion," conceive the same thoughts as to the principles, and the modes of applying the same, so as to reach

a given and important end by mechanism, but within the same week — the same day, even.

The adoption of hammers was certainly the greatest improvement which had been made in the growing instrument for centuries; but notwithstanding all its superiorities and advantages, it did not meet with that favor to which it was entitled; and for nearly half a century it struggled for supremacy with its already established rivals, till finally some makers, in order to overcome all prejudices, put two key-boards into one and the same instrument, like the keys of an organ. One row of keys operated on the old-fashioned jacks and quills, producing a tone which has been described as "a scratch with a sound at the end of it," and the other row was supplied with the newly invented hammers. What has followed that test of the relative merits of the two models described, is too generally understood to need comment here.

The first piano-forte in England, so far as is now known, was the work of an English monk at Rome; and it was brought to England about the year 1757. Piano-forte makers from Germany came over to England about 1760, some of whom obtained much celebrity. A play-bill of Covent Garden Theatre, bearing date 1767, announces the production, on the stage, of a piano-forte, which it denominates as a "new instrument." Letters patent were granted to Joseph Merlin, in 1774, for an improved harpsichord, with hammers, on a plan similar to that of the piano-forte. But the English makers assert a positive claim to the invention of the first "grand action." It is admitted that about 1772 a German, by the name of Amercus Backers, and John Broadwood, and Robert Stodart, the three being then in the employ of Burckhardt Tscudi, the distinguished manufacturer to whom we have alluded herein, conjointly succeeded in applying to the harpsichord an action like that then in use in the piano-forte. That action was in principle the same as that still preserved in the Broadwood instruments; and in an improved form is the same now used by the leading piano-forte makers of this country. It is simple, efficient, and durable, and is called the direct action; and with improvements, it is the form now used by Messrs. Chickering & Sons.

In the early piano-forte all parts of the instrument, scale, stringing, sounding-board, and action were very imperfect, and its resources limited, the best pianos having only a compass of five octaves. Improvements and new applications have been con-

stantly made, and during the past twenty-five years the progress towards perfection has been very rapid and marked. The compass of the key-board has been increased to seven and seven and a fourth octaves; the old-fashioned brass strings have given place to steel; the power (tone) of the instrument has been enlarged more than four fold; and the action has been brought to a degree approximating a perfection not even dreamed of, or hardly dared to be hoped for, by the makers of the last century.

Probably to no one person ever interested in the manufacture of piano-fortes are the musical public, and those at present engaged in the business, more indebted for early improvements in the general construction of the instrument, than to Sebastian Erard, who commenced his career in Paris in 1768; and after building up an immense business, as the result of his many successful experiments and improvements, died in 1841, leaving a name and a reputation which must forever be remembered with respect by all persons connected with the profession of music or the manufacture of piano-fortes.

For years the ingenuity of rival makers has been exerted to the utmost to improve the instrument in power and quality of tone and delicacy of touch. We say nothing of the many inventions and applications of attachments and combinations of other instruments in the same case with the piano-forte, or of the latter with transposing key-board, or any of the new features adopted in order to attract notice; the real improvements which have been made, consist of the extending and laying out of the "scale," the weight of strings, proportions of sounding-board, the strengthening of the case, and perfecting the mechanism of the action, thereby so increasing the resources of the instrument, that the artist or performer may the more readily and with greater effect give expression to his musical thoughts.

Since the days of Muzio Clementi (the eminent pianist, and author of a large work on the art of piano playing, *Gradus ad Parnassum*, and who was born at Rome in 1752, and was mainly reared in England, and died there in 1832), the elaboration and modifications of the action have been constant and important.

The Erard, Broadwood, Collard, Wornum, and Chickering actions, all embody important principles, and have served to render the piano, in its present shape, one of the most exquisitely sensitive and expressive embodiments of musical power, which the most enthusiastic or poetic composer could wish. That wonderful mech-

anism it is impossible to intelligibly describe without cuts and specifications, neither of which would add to the general interest of this article, which aims to give only the great facts in the line of the progress of the musical instruments which have developed into the piano-forte, and the general outline of the great features of the latter.

In the earlier instruments with small strings the frame was made of wood only, and truthfulness of tone in the instrument was all that the makers sought to achieve, depth and power being simply impossible. But iron finally came to be used for the "piano-frame" (not the case, but the parts supporting the strings), and this plan of frame is generally used in Europe; and with the use of larger strings and iron frames has come greater depth and power to the instrument. The strain upon the frame, made by the tension of the strings, being enormous, — amounting to many tons, — it will be readily understood how necessary to efficiency the iron frame is. No wooden frame yet devised can withstand the strain. Hence it is that wooden frame piano-fortes must be tuned every few days. The iron frame piano-fortes, of the Chickering style, may go six months or more without necessity of tuning. As iron is susceptible of being finely wrought without depreciating its strength, the iron frame does not add appreciatively to the weight of the instrument; while that as now constructed the iron work does not injure the tone of the piano-forte is sufficiently proven in the Chickering pianos, which in depth, purity, richness, evenness, and power of tone are unsurpassed by any in the world, as we are assured by such great artists as Thalberg, Gottschalk, and De Meyer, whose opportunities of observation have been world-wide. No piano-forte but an iron frame instrument, with a case made from the very best and most thoroughly prepared stuff, can successfully withstand the extreme climatic changes of this country, the weather on one day being exceedingly damp and humid, swelling all furniture perceptibly, on the next day dry and arid, creating gaping joints; at one time cold, at another hot. Nothing less than iron-like solidity, the utmost thoroughness in the preparation of material, and the most perfect skill in construction, can suffice to withstand the searching test of the American seasons.

There is a vast number of piano-fortes constantly in the market, some excellent, others good, many of indifferent character, and very many absolutely bad — for a poor piano is but at best a

cumbersome nuisance. It is remarked by a distinguished writer as a curious fact, that "but few persons, *even among good performers*, know anything of the construction of the piano, or are capable of judging critically and artistically, the difference between a good and poor instrument." This being true, it would please us to be able to give in this article some rule or guide to purchasers in general how to make judicious selections. But no rule for individual guidance can be given which does not comprehend the possession, to start with, of a perfect acquaintance with music and mechanism ; indeed, with the whole matter of manufacture of piano-fortes in detail, as related to musical expression and effects, strength of metals and woods, resonance of the same, effects of climate, and many other considerations. The best suggestion then, which we are able to make comprehensively, is, that purchasers who have any question of their own perfect, critical judgment, should, if they desire to make a safe investment for their lasting satisfaction, select from instruments among those of manufacturers whose reputation is a guarantee of the perfection and reliable character of their work. Among all arts, the leading manufacturers cannot afford to put off upon the public imperfect wares. It was a remark of that sagacious though eccentric man, John Randolph of Roanoke, that the largest establishments are always the best to procure good articles from of any kind ; an observation which has peculiar significance when brought to bear upon the article of piano-fortes.

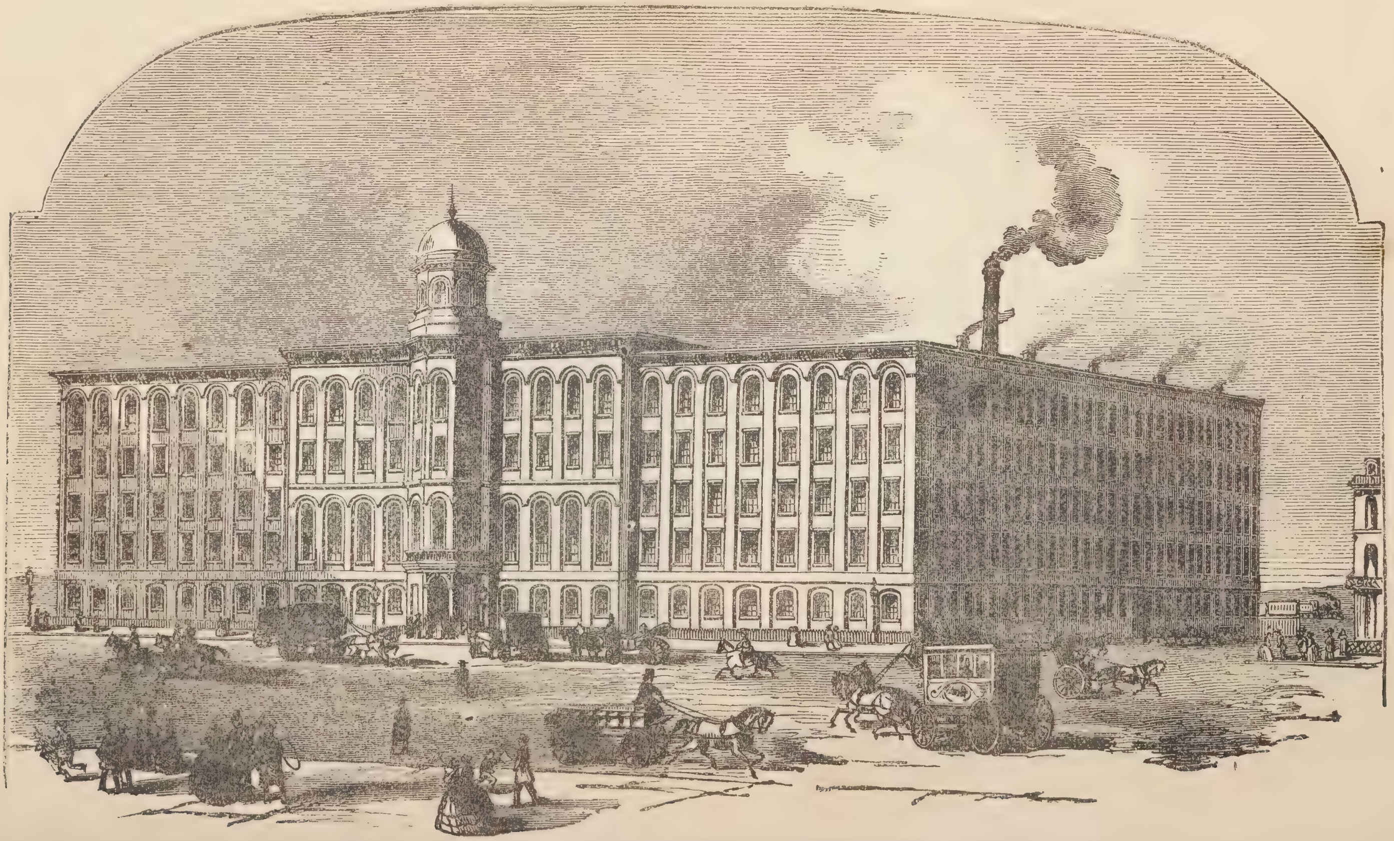
As the representative or leading manufacturers only, in a given art, are referred to by name in this work, and under the heads of some of the articles thereof it is so difficult to determine who or what house is the leading manufacturer in this country, that in justice to the truthfulness of history, we are obliged to avoid designating any one as the principal, *par excellence*, or leading man or firm of these times ; for example, as regards that important manufacture and extensively used and necessary implement, the scythe, it would be difficult to decide who, out of a large number of excellent manufacturers, makes the best, or manufactures the largest quantity of really good ones, and who is therefore the leading man or "house," in the purview of this book. But in the matter of piano-fortes, the difficulty of discrimination is happily not cast upon the writer of this article, judgment having been long since pronounced by musical critics and people at large. Whatever may be the special taste or opinion of a single individ-

ual, here or there, upon the relative merits of other piano-fortes than those manufactured by the Messrs. Chickering & Sons, the spacious piano-forte manufactory of this house, at Boston,—the most extensive manufactory of pianos in the world,—indicates unanswerably that they are the leading house in this country, both in the extent of their manufactures, and the popular favor, without which their vast establishment could never have had existence, or, when created, continued to exist.

This house was founded by Mr. Jonas Chickering, who was the first to introduce the iron frame entire in the construction of the piano. This course he adopted as early as 1838. It was a highly important improvement, adding immensely to the solidity of the instrument, the permanence and purity of the tone, and the resources of the key-board, on account of the additional strings it permitted. Mr. Chickering was also the sole inventor of the circular scale, now so generally used by manufacturers in this country and in Europe. It was first used (or published) November 29, 1845. It was not secured by letters patent, the inventor regarding it as one of those things which, for the greater good of art, all should be permitted to use.

The improvements which Mr. Chickering made in the entire construction of the piano-forte were numerous. His whole mind was absorbed by the idea of a perfect instrument; and to secure such a desideratum he labored, experimented, sought advice and assistance, and left no means untried which could aid his endeavor. This indefatigable man died December 8, 1853, just as he had entered upon the building of that noble structure to which allusion is hereinbefore made, and which constitutes the manufactory of the firm of Chickering & Sons. By the death of Mr. Chickering, the country lost one of its representative men, of most distinctive mark. Uniting to a wonderful inventive power, an incorruptible integrity, an indomitable will, unflagging industry, and a business faculty, as sagacious as it was comprehensive, he was just the man to found and perfect the important business to which the best energies of his life were given. When, in the course of time, America comes to do honor to her sons who have rendered her an honor to the world,—her classic dead,—the name of Mr. Chickering will have a high place in the temple of fame.

Mr. Chickering left behind him three sons, all of whom had been carefully educated for the responsible trust which he confided to them—that of perpetuating the reputation and business of the



CHICKERING & SONS' PIANOFORTE MANUFACTORY, TREMONT STREET, BOSTON, MASS.

house. The sons unite, in a large degree, the tastes and talents of the father. Upon his death they assumed the entire conduct of the immense business, and have from that time so enlarged it, step by step, and added to its reputation, that now the firm stands first among piano manufacturers and dealers in America, indeed, in the world; for even Erard, Pleyel, or Broadwood are names no fairer in Europe among connoisseurs, than that of the American house of Chickering & Sons.

It has been remarked before in this article, that the manufactory of Messrs. Chickering & Sons located on Tremont Street, Boston, Mass., is the most extensive one in the world. Considered in this light, it is an object of attraction, ornament, and pride for our country; but its general or objective interest is doubly heightened by the reflection that its magnitude indicates the rapidly increasing culture of music in the United States.

So complete and well appointed, as well as large is this establishment, that we regard it and its business conduct (as suggestive to capitalists and builders, as well as instructive to the general reader) as worthy of somewhat detailed description in the conclusion of this article.

The premises occupied by this gigantic structure comprise an entire square of about *five acres*. The plan of the building forms a hollow square; the principal front is on Tremont Street, and sets back 18 feet from the inside line of the sidewalk; the front measures 245 feet on the street, by 552 feet deep, exclusive of a projection in the centre for the tower, which is of octagon form, 21 feet at the base, and rises to the height of 110 feet. The north wing, fronting on Northampton Street, is 262 feet long, by 50 wide. The south wing, fronting on Camden Street, is 250 feet long, by 50 wide. The westerly front, closing the square, is 60 feet by 70, with wings, each 32 feet wide, connecting the main wings of the building; here are located the steam engine, 125 horse-power — six of the largest sized boilers, saw-mills, veneer saws, and veneer-cutting machine. The main building and wings are separated by fire-proof, vaulted brick walls, two feet thick, with double sets of iron doors, doubly bolted and barred; which, with the facilities at hand for water, render the destruction of more than one building or wing at a time, by fire, next to an impossibility. The whole edifice stands six stories high on the three streets, the rear, or westerly wing, being three stories. All the rooms are 11 feet in the clear between floor and ceiling, except the

front and centre on the second floor, comprising the grand staircase, entrance hall, and warerooms, which are 22 feet high, and the staircase 7 feet wide. Elevators or platforms, 10 feet by 6 in size, are operated by steam in each wing, for passing up or down, between cellar and attic, thus performing all the necessary moving from one room or story to another, in the easiest and most expeditious manner.

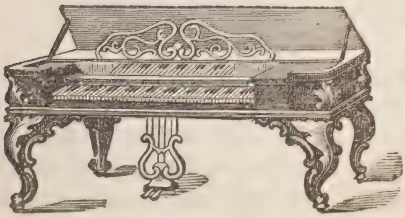
The whole of this grand building is devoted exclusively to the manufacture of piano-fortes, and all the interior arrangements for the business are on a scale to correspond with what has already been described. The rough stock is taken in at the lower door, in one wing, and passing up this wing, through the main building, and down the other wing, is delivered in the warerooms finished, so that, almost literally, "forests enter at one end of the building, and come out perfect pianos at the other." The entire first floor is filled with the requisite machinery, such as planers, lathes, all kinds of saws, moulding machines, jointers, etc., and exhibits the finest and largest display of machinery in any one building, occupied as a piano factory, in the world. Every known improvement has been introduced into the various departments of this manufactory, in order to make it and its work as near perfection as human skill, employed with the most ample means, can accomplish. The space in the rear of the factory is used as a lumber yard, and has three large drying-houses for seasoning lumber. In this yard and the dry-houses are kept constantly on hand about 1,500,000 feet of the very best of the different kinds of wood used in the construction of pianos. No fires of any kind are allowed in the building, either day or night. The entire edifice is heated by steam, and lighted by gas. The iron pipe used for steam and gas, if laid out in a single line, would reach a distance of eleven miles. In the case-making and sounding-board rooms are immense heating-ing boxes of cast iron, enclosed in masonry, lined with steam-pipes, capable of raising the temperature to over 200 degrees. The varnishing department comprises the entire top floor, extending the whole length of the front and side buildings, a distance of 750 feet.

A private line of telegraph connects the office of the factory with the warerooms on Washington Street, a distance of about one mile. A magnetic clock, situated in the private office, notifies the firm, in the morning, of any delinquency or carelessness of the night watchman in his duties. The store-room on the first floor,

where the felt, cloth, ivory, screws, hinges, and general assortment of hardware are kept, is quite as large as many of the largest city retail stores.

All parts of the business are carried on in this one building. No outside contracts are made, nor are any parts of the piano purchased from other makers or dealers. Each department is governed by a competent and skilful overseer, who is fully responsible to the Messrs. Chickering for all the work done in his branch.

All the scales and patterns are drawn and made by the Messrs. Chickering themselves, and everything, even to the smallest detail, is so thoroughly systematized, that the smallest deviation or delinquency of any workman from the regular and authorized course, is known at once by the heads of the firm.



MOWERS AND REAPERS.

THE SLOW PROGRESS OF MECHANICAL INVENTIONS RELATING TO AGRICULTURE. — FITZHERBERT'S "BOKE OF HUSBANDRIE" CITED. — THE PRIMITIVE SICKLE AND THE MOWER, A CONTRAST. — VARIOUS METHODS OF GATHERING GRAIN AND GRASS, FROM REMOTEST ANTIQUITY TO THE PRESENT TIME. — REPRESENTATIONS IN BAS RELIEF ON THE TOMBS OF EGYPT. — THE "ANI ANI" OF JAVA. — THE REAPER IN ANCIENT GAUL; PLINY THE ELDER'S ACCOUNT, PALLADIUS, ARTHUR YOUNG, WALKER. — FIRST LETTERS PATENT GRANTED IN ENGLAND FOR A REAPER, 1799. — OTHER PATENTS. — THE FIRST MOWING AND REAPING MACHINES VERY COMPLICATED. — SALMON'S, BELL'S, AND OTHERS' MACHINES. —AMERICAN REAPERS. — HUSSEY'S MACHINE. — ONE-WHEELED MACHINES SUPERSEDED BY THE TWO-WHEELED. — MR. RUFUS DUTTON'S INVENTION. — GREAT TRIAL OF MACHINES AT AUBURN, NEW YORK, 1866. — REPORT THEREOF. — MR. DUTTON'S GREAT VICTORY. — THE "CLIPPER MOWER AND REAPER COMPANY" NOW THE REPRESENTATIVE MANUFACTURERS. — THE NUMBER OF MOWERS AND REAPERS ANNUALLY MANUFACTURED IN THE UNITED STATES. — THE SELF RAKE.

Whatever relates to agriculture must be of primal interest to man, "of the earth, earthy;" and, in fact, the history of agriculture from the remotest period down to this time would necessarily involve what has been most important to the race in all time. It is a natural law, that man shall live by the sweat of his brow; that from the bosom of the earth he shall, by greater or less toil, draw his sustenance. And when surveying the wide field of manufactures, one is struck with astonishment at the comparatively few inventions and improvements which have been made in the field of labor-saving machinery adapted to agriculture. In a large portion of the world, the primitive or simplest forms of implements of husbandry are still in use. The plow now used generally in the Roman states, and, indeed, throughout Italy, is but a slight improvement on that there used two thousand years ago; and the straps or ropes by which it is attached to the cattle which draw it are fastened about their horns, the shoulder yoke not

being much employed. But the experiences of one country, or climate, are not like those of another; and the customs of husbandry adapted to one portion of the earth are seldom suited to another portion; so that one nation has not borrowed so much from another, or profited so much from its real progress in the line of agricultural inventions, as in those of many other arts of peace, or of the art of war, especially; for in the latter, one nation must keep pace with another, or consent to be reckoned as an inferior power, and suffer the consequences of weakness or want of skill — be "absorbed," "annexed," or "trampled out of existence," it may be.

We have not the space to indulge in speculation or philosophizing as to the various reasons which have retarded progress in the line of labor-saving implements of husbandry; but we may remark, *en passant,* that in ancient times more than now, man seems to have been more of a pastoral animal than an agriculturist proper. He lived more with and upon his flocks, and upon the fruits of trees and vines, and less upon the cerealia and cultivated vegetables, than the race now does. We find Sir Anthony Fitzherbert declaring himself as follows in his "Boke of Husbandrie," in 1534 (the first agricultural work published in England): "A housebande cannot thryve by his corne without cattell, nor by his cattell without corne; shepe, in myne opinion, is the most profitablest cattell that any man can have." Sir Anthony had then had forty years' experience as a farmer, and undoubtedly uttered the then prevalent opinion on the subject.

The contrast between the primitive Sickle and the Mower and Reaper of these days is as wide almost as between that of darkness and light; or more fitly perhaps, and less exaggeratedly, may be, between the classic "fig leaf" of the primal garden, and the toilet of the modern belle with her deftly woven silks, her laces subtly wrought by aching fingers, her cashmere shawl made of the exquisite wool of unborn lambs, and her diamonds, found after years of the discoverer's ceaseless searching, and set in braided gold.

A pertinent comparison or contrast of the past condition with the present state of mechanics as related to agriculture might be made between the Norman Plow and its driver (as represented in the article on "Axes and Plows" p. 121,) and the Mower "at work" in the field, as it appears in this article, with its wondrous conjunction of power and celerity of operation, "its weird combina-

tion of mechanic powers," and its marvelous adaptation of means to the ends of victory.

But we cannot probably better serve the reader at this point, than by presenting him with the various methods of gathering grain, grass, etc., from the remotest antiquity to this time, in a description which, we trust, will not be found wanting in pleasing interest and positive value.

The time-honored sickle, still in use, is the earliest known reaping implement. We find it mentioned both in the Hebrew legends, and the Christian scriptures. That it was used by hand only, and not as a part of a machine, may be inferred from a passage in Isaiah xvii. 5. This was obviously the case in Egypt, judging from the bas reliefs upon some of the buildings and tombs, where reapers are represented using sickles, some with smooth, and others with serrated edge. Two of these ancient Egyptian iron sickles, much rusted, are displayed in the "Gallery of Egyptian Antiquities," in the British Museum, London. In Java, an instrument has been in use from time immemorial for reaping grain, which is described in Sir Thomas S. Raffles' history of that island. The description of the "ani ani" being very vague, it is difficult to form a correct opinion of the manner in which it is used; and the figure does not remove the doubt. We surmise, however, that the reaper takes one of the parts in each hand, and in passing them, like the blades of shears, over each other, the straw is cut, and by the same act the head of grain is thrown into a basket or apron worn by the reaper.

The first account of a machine to reap grain appears to be that given by Pliny the elder, who was born A. D. 23. He says, "In the extensive fields in the lowlands of Gaul, vans (carts) of large size, with projecting teeth on the edge, are driven on two wheels through the standing grain, by an ox yoked in a reverse position. In this manner the ears are torn off and fall into the van." Such an idea of a reaping machine is very like that of the ancient war-chariots, to the sides of which great blades were fastened, and the horses thereof driven into the ranks of the opposing army, thus to reap a harvest of human heads. As Palladius (an Eastern prelate, born A. D. 391) gives a similar account of this machine in the following words, it is more than probable that its use was continued through centuries. After describing the forms of the van and the attachment of the animal, he continues, "All the ears are caught by the teeth, and fall in a heap into the

cart, the broken stalks being left behind. The driver, who follows, generally regulates the elevation or depression of the teeth, and thus, by a few courses backwards and forwards, the whole crop is gathered in the space of a few hours. This system is useful in open level places, and in those where straw is not absolutely wanted." In vol. iv. p. 205 of the "Annals of Agriculture and other Useful Arts," collected and published in 1785, by Arthur Young, F. R. S., etc., appears what is believed to be the earliest proposal for a mechanical reaping machine in Great Britain. In vol. viii. p. 161 of the same work (1787), there is an account of a reaping machine, suggested by the descriptions in Pliny and Palladius, and invented by William Pitt, of Pendeford. It consisted of a reaping or rippling cylinder, composed of numerous parallel rows of curved teeth. This tooth cylinder is suspended in front of a two-wheeled car, and motion communicated by means of a pinion and cog-wheel, connected to the car-wheel by a band and pulley; the iron combs of the cylinders hatcheling off the heads of grain and dropping them into the box behind. In "Walker's System of Philosophy in Twelve Lectures" (1799), there is a description of a reaping machine, though by whom invented, or when, does not appear. The movement of the cutters is represented as being circular. The knife wheel is put in motion by a pulley fixed on its axle, and made to cut like shears against the sharp edges of steel points projecting beyond it into the standing grain, the cut wheat being removed from the platform by a lever attached to the axle of the cutter-wheel. The whole is pushed forward by a horse.

The first patent for a reaping machine in England was obtained by Joseph Boyce, of Pine Apple Place, Mary-le-bone, on the 4th of July, 1799. On the 20th of May, 1800, letters patent were granted to Robert Mears, of Somersetshire, for a machine reaper. This was an apparatus worked by hand, although propelled upon wheels. On the 15th of June, 1805, Thomas J. Plucknett, of Kent, England, obtained a patent for a reaping machine, in which the motive power or "team" was placed behind, and the cutting apparatus suspended beneath and forward of an axle connecting two large driving wheels, and worked by gearing. The cutter was a plain, circular, smooth-edged plate. The Edinburgh Encyclopædia, vol. i. p. 262, gives a description of a reaping machine, having an arrangement for gathering grain, and delivering it in small sheaves, produced in 1806, by Mr. Gladstone, of Castle Douglass. In this

machine, "the horse goes in front beside the uncut grain." This is the first mention of a harvesting machine where the horses go before the machine, and beside the uncut grain; and it is the first reaping machine we have an account of which had an arrangement for gathering the grain, and delivering it on the ground in sheaves or bundles. The cutter was a smooth-edged circular knife, acting upon the grain confined against strong wooden teeth which projected forward and above the blade. The cutting edge was kept sharp by means of two small circular pieces of wood, coated over with emery placed below and above it, and made to revolve rapidly against it.

On page 422 of Loudon's "Encyclopædia of Agriculture," there is an account of a reaping machine designed by a Mr. Salmon, in 1807. Its cutting operation is like that of a pair of shears, to which power is transferred from the driving wheels by gearing similar to that very generally adopted in reapers at the present day.

Up to this time all the different devices for reaping machines were very complicated. The invention of Henry Ogle, schoolmaster of Remington, in 1822, marks the commencement of a new era in reaping machines. Mr. Ogle seems to be the first who invented and used a reciprocating cutter. His machine was one of extreme simplicity. From a trial of this machine, it was estimated that it would cut fourteen acres per day with ease; but Mr. Ogle, schoolmaster, says, "Some working people threatened to kill Mr. Brown (the maker of the machine) if he persevered any further in it, and it has never been more tried." Up to this period, notwithstanding the ingenuity which had been expended upon reaping machines, none had been produced which has stood the test of time, or which embraced all the principles that have been incorporated in the effective reapers of the present day; but in 1826, the Rev. Patrick Bell, of Scotland, invented an apparatus for reaping grain, which is the oldest known machine that is still in use. This may be said to be the advent of successful reaping by machinery. In this (Bell's) machine there was the adjustable reel, as in Ogle's clipping cutters; a method of raising the cutters, and also a mode of delivering the cut grass in line on the ground, to allow any number of binders to work after it. Various trials were made with this machine in 1828 and 1829. One made in September, 1828, in the presence of fifty farmers, elicited from them a signed declara-

tion, that moved by one horse it cut an acre per hour of oats. In September, 1829, the same machine was worked at Monckie, in the presence of a large number of persons, who also attested that it cut half an acre of heavy lodged oats in half an hour. It was also tried in a number of other places in the same year. It is described in Loudon's Encyclopædia of Agriculture.

Although there is unquestionable proof respecting the successful working of this machine in 1828, it does not seem to have attracted much attention, as it was lost sight of entirely, until England was awakened to the utility of reaping machines, in 1851, at the Great Exhibition. "The credit of effecting this (the whole English press has declared) is undoubtedly due to American inventors, whatever may be the ground for disputing the novelty of the two rival American reapers" (McCormick's and Hussey's). After the accounts regarding the American reapers at the World's Fair were published abroad, it was claimed that the American reapers were no more than copies of British reapers, and that one of Bell's machines had been early sent out to America, from which, it was hinted, the American inventors had supplied themselves with ideas. One of Rev. P. Bell's horse power reaping machines was imported by John B. Yates, in 1834, who used it about two years, until the time of his death, after which we have no account of its being continued in use. It is not probable, therefore, that the inventors of American machines are at all indebted to Mr. Bell or any other foreign inventors for their ideas.

About this time the attention of inventors, in different parts of the world, seems to have been awakened to the importance of harvesting machinery. One was invented in Odessa, in 1831, one in Vienna, in 1839, and one in Australia, in 1845. From this period up to the time of the Great Exhibition in London, in 1851, there were nine letters patent issued in England for reaping machines and improvements thereon. The World's Fair was the commencement of a new era in the department of agricultural machinery — of reaping machines particularly. From the closing of the Crystal Palace, in 1851, to the end of the year 1852, there were no less than twenty-eight inventions registered, and English patents granted for inventions relating solely or partially to reaping and mowing machines. Few of them are of sufficient interest and present importance to demand a notice.

The foregoing descriptions embrace the history of reaping machines in foreign countries up to the year 1853.

American Reapers.

The attention of our countrymen was directed at an early period to the importance of reaping machines, and we find that a patent was granted on May 17, 1803, to Richard French and J. T. Hawkins, of New Jersey. In a letter written by the son of the inventor, he says that his father constructed a working machine, and tried it in a field of rye, and that it cut a large quantity of the grain. Why it was dropped he cannot tell. The reaper was supported on the wheels — one wheel extending into the grain. The horses drew in front, or rather at one side, opposite the cutters, which were a series of scythe-knives, revolving on a vertical spindle — a rotary reaper. Beneath the cutters were long wooden fingers, extending some distance into the grain, and supporting the grain to the action of the revolving cutters. Directly behind the cutters were fingers that passed between the cradle fingers, and removed the cut grain, which fell to the ground ready for binding.

Obed Hussey's machine was patented in 1833, and contained nearly all the main features of those used at the present time. His machine was intended to cut both grain and grass, and had a reciprocating knife and a slotted guard finger, both of which are now used on all harvesters.

As Hussey's, therefore, is still in use, and was a successful machine from the first, it must embrace features peculiarly fitted to accomplish its work. The first public trial in the harvest-field with Hussey's reaper took place on the 2d of July, 1833, before the Hamilton County Agricultural Society, near Carthage, Ohio. Dr. Wallace, secretary of the society, gave a certificate, dated the 20th of November, of that year, in which he states, " that he saw the machine operate on a field of wheat, which it cut clean and with great rapidity, and that it established one point satisfactorily, namely, that it was constructed on a principle to operate." There was also a certificate of nine witnesses of the same trial, in which they state, " that although the machine was not well constructed (mechanically merely), its performance far exceeded their expectations." In 1834 this machine was introduced into Illinois and New York, and in 1835 into Missouri, in 1837 into Pennsylvania; and in 1838 Mr. Hussey removed from Ohio to Baltimore, Md., where he continued to manufacture his reapers.

We will now let Mr. Hussey speak for himself. "There is no account of any successful reaper in ancient times, and it is well known that England and Scotland never produced any up to the time of the London Exhibition of all Nations, in 1851; it consequently follows that the claim of priority is clearly confined to the

AT WORK.

United States. The question therefore is, who originated the successful reaping and mowing machine?

"I do not desire to urge any unjust claim for myself, but I wish to maintain the credit which is justly due to me. It is known to the country, and by farmers in particular, that there are at the present day several successful reaping machines, which are known

by different names; but it is not generally known that all of them, without exception, embrace substantially the principle invented by me, and exhibited by myself in successful operation, in the harvest field, as long ago as 1833; and however surprising and unexpected this statement may appear, it is nevertheless true, that there is no successful reaping and mowing machine now in use without it. Most of the reaping and mowing machines of the present day are of recent date; nearly all of them are little more than copies of my invention. The old Roman machine seems to have been little more than a cart, backed up to the wheat. This mode of approaching the grain was followed by the Scotch and English inventors from the remotest period in the history of reapers down to 1854. The earliest of these English and Scotch machines appear to have been constructed on the rotary principle, the cutting instruments being placed on the periphery of a large horizontal wheel, which revolved near the ground. Bell, of Scotland, at a later period used scissors. His machine presented to the grain a row of pointed blades, which operated like a series of tailors' shears, but it was soon pronounced a failure.

"The American reaper woke up from a long sleep in 1851. It was resuscitated, and flourished for a brief season, took the English and Scotch prizes in 1851, by especial favor, and was again condemned at the late meeting of the Royal Agricultural Society, held in Lincoln (England), the present year (1854)."

The first machine made by Hussey, as well as others made at that time, were what might be called two-wheeled machines; that is, having two large wheels to support the frame, of equal or nearly equal size, and with the finger-bar extending out from the side of the machine.

Hussey afterwards changed his machine by substituting one wheel for the two-wheel previously used: so did McCormick.

The two-wheel machines seem at that time to have gone out of use (1850), and came into use again about the year 1854, or 1855, when two-wheeled machines having the *hinged* finger-bar were introduced, foremost among which were the "Buckeye" and the "Cayuga Chief."

There are other improvements connected with the two-wheeled machine, such as making both wheels drivers, regulating the height of finger-bar, etc.; and although the one-wheeled machines are still used to some extent as reapers, those having two wheels have already almost entirely superseded them as mowers, and are largely used as reapers.

The leading principles in the operation of harvesting machinery, may now be considered as fully established, and the attention of inventors and manufacturers will, no doubt, be directed to further simplifying the construction of the parts, and adding to their convenience and ease of management.

In the application of principles already established, there are now used in all first-class mowers, two driving wheels, which support the body of the machine, and give motion to the knives, through the gearing; a frame which supports the gearing, and to which is attached the cutting apparatus and the draught-pole; the gearing; the cutting apparatus, consisting of a reciprocating knife, operating in and supported on a finger-bar, with shoes at each end, and having guards or fingers projecting in front to protect the knives and assist in cutting. In addition to these, the reaping machines have reels and platforms for the purpose of gathering the grain, and delivering it on the ground in gavels suitable for binding.

Although the general arrangement of these parts is similar in the machines now most prominent before the public, there are many, and in some instances material points of difference in their construction; and we mention, as some of these points, the style of driving wheels, some being made of cast and wrought iron, others of cast only; the manner of connecting the driving wheels to the gearing, so as to best admit of throwing the machine in and out of gear; the number of gears, some having two, and others three pairs; the frame, some using iron only, others wood; besides different devices for uniting the finger-bar to the frame, so that it will conform to the inequalities of the ground, and be raised, to clear obstructions, while at work, and secure convenience in transportation. Some finger-bars are made of iron, and some of steel, and differ in shape. The guards or fingers also differ in shape, and are made from different kinds of metal. The manner of attaching the draught is of the utmost importance, in order to avoid, as far as possible, what is called "side draught," and differs in some of the leading machines; also the location of hand levers convenient to the driver, to enable him to adjust the cutting apparatus, with as little inconvenience as possible, to the surface of the ground, and to raise it over obstructions.

Particular attention has been given within the last few years to the cutting apparatus, which includes the finger-bar, knife, and fingers. The first finger-bars were made of wood, but now

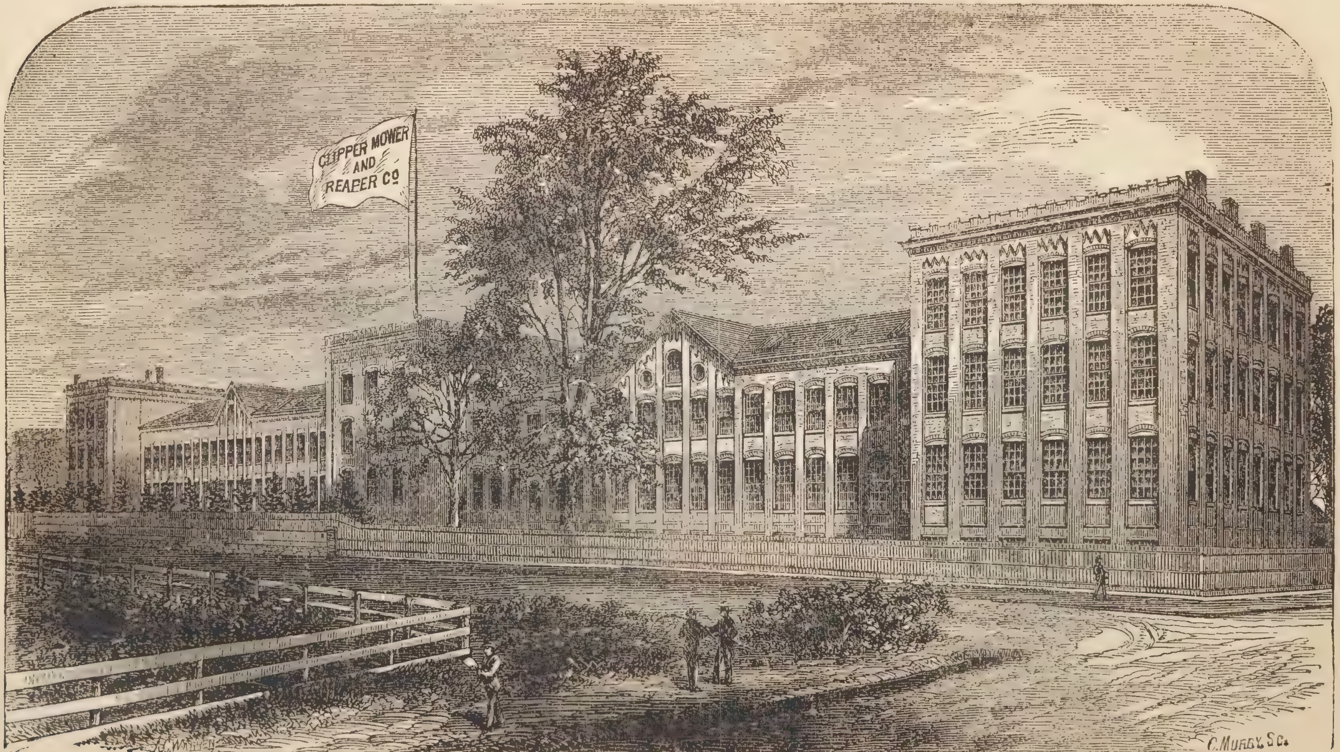
wrought iron and steel are exclusively used. The knives have been the subject of many experiments, to determine the proper motion, and the best size for a blade or section. The fingers or guards were first made of wood, next of cast iron, then of wrought and malleable iron, afterwards improved by the use of steel cutting plates. A solid cast-steel guard is used on the so-called "Clipper" machine.

The earliest machines made would cut only dry and coarse grass, and work on uplands; and it was thought, until within a few years, that it would be impossible to mow grass while the dew was on. A good machine of the present day, however, will mow in all kinds of grass, whether wet or dry, coarse or fine; and some builders warrant their machines to work well in any place where the farmer is willing to ride or drive.

The competition among builders has been, and is now, very great, and has stimulated invention, until more than two thousand patents pertaining to harvesting machinery have been granted in this country.

Probably the machine which has been brought to the greatest perfection at the present time is the Clipper mower. It is the invention of Mr. Rufus Dutton. We quote from the report of the great trial held at Auburn, N. Y., in 1866, when fifty-four different machines were on exhibition, including nearly every harvesting machine of any importance in the country. "Among the candidates for the favor of the agricultural public, few have made more determined or more ingenious efforts to carry away the palm, than the inventor of this machine. He has proposed to himself to construct a machine which shall have the greatest strength with the lightest material, aided by the best possible workmanship, combining security for the driver, convenience of management, and adaptation to uneven surfaces; and, in short, which shall meet all the wants of the farmer in the greatest possible degree. . . . The mechanical execution of this machine reflects the highest credit upon Mr. Dutton, the inventor; in this respect it surpasses all the rest. All the bearings are as smooth as machinery can make them, all the joints are closely fitted, all the working parts are mathematically in line, all the materials of which it is composed are of the best that can be procured."

In 1867 the "Clipper Mower and Reaper Company" was organized, with a large capital and ample facilities for manufacturing these machines, and has already become the representative house



WORKS OF THE CLIPPER MOWER AND REAPER COMPANY, YONKERS, N. Y.

in this line of manufactures. The company constructed extensive and expensive machinery expressly for this purpose, and now manufacture the "Clipper" machines, greatly improved in every respect, both in materials used and in workmanship, also in style of finish, over those used at the Auburn trial in 1866. The

PASSING AN OBSTRUCTION.

engraving represents this celebrated machine in the field at work. Their manufactory, of which we present a view, is at Yonkers, N. Y., the company's business centre being New York city.

For four or five years past, from eighty to ninety thousand machines have been made annually in the United States, and the

capital employed is not less than ten millions dollars. A large number of establishments are now engaged in this business, among which may be mentioned, as the most prominent, those making the "McCormick," the "Buckeye," the "Kirby," the "Wood," and the "Clipper" machines, each of which turns out a number of thousand every year.

But perhaps one of the best, among the late improvements on mowing machines, is the *steel guards*, controlled by letters patent, and used exclusively on the "Clipper" machines. These have been perfected at a great cost of time and money, and are worthy of especial notice. They are forged from solid cast steel, and after being shaped under a drop-hammer, the slots are cut, by milling machines, perfectly smooth and uniform in all respects. The cutting surfaces aud points are then hardened, while the remaining parts of the guards, to secure the greatest strength, are left untempered. The hardened points do not become dulled or bent by stones, or other obstructions, so as to catch fine or dead grass, or anything else; after being ground and polished they are ready for the finger-bar. No arguments are required to convinee any one of the superiority of steel for this purpose, as it is more than twice as strong as the best wrought iron, and three times stronger than malleable iron. These guards will not break with the roughest usage. On over twelve thousand machines, hardly an extra one has been required to supply breakage — a fact which will suffice, we think, to demonstrate these steel guards as an advanced and needed step in the line of a great progress.

IRON AND ITS PREPARATION.

THE IMPORTANCE OF IRON. — ITS GENERAL DIFFUSION. — AMONG THE EGYPTIANS. — MENTIONED IN THE BIBLE. — AMONG THE GREEKS. — AMONG THE ROMANS. — IN MODERN TIMES. — CAST IRON. — ITS FIRST PRODUCTION. — IMPROVEMENTS IN THE PROCESS. — PUDDLING IRON. — INVENTION OF THE BLAST. — THE USE OF ANTHRACITE. — THE ORES OF IRON. — THE MAKING OF IRON IN THE UNITED STATES. — EARLY ATTEMPTS IN VIRGINIA. — IN MASSACHUSETTS. — THE FIRST FURNACE. — WORKMEN EARLY ENGAGED IN THE MANUFACTURE. — CASTING IN SAND. — PROHIBITION BY PARLIAMENT. — THE COST OF A FURNACE. — THE EFFECT OF THE REVOLUTION. — THE POLICY OF THE GOVERNMENT. — THE BESSEMER PROCESS. — APPLICATION OF SPECTRAL ANALYSIS.

Iron, while being the most useful of all the metals for the various arts, is also one of the most generally diffused of the products of nature. In one form or another, it is almost universally diffused through the organic and inorganic world. Not a stone or a rock can be found without a trace of this metal. Nothing is visible around us which is wholly devoid of it. It is found in our blood, and intensifies the brilliant colors of the rose, while spectral analysis has traced its presence in almost all the stars.

The history of its discovery and use is lost in the remoteness of antiquity, since, from its affinity for oxygen, and its consequent tendency to rust, and thus lose its form, it can hardly be expected that any tangible evidence of its use in ancient times should have been preserved to our day.

It appears, however, from Layard's *Nineveh and Babylon*, that the Assyrians were well acquainted with the manufacture of iron, and that they employed it, together with bronze, in useful and in ornamental works. They had also the art of coating iron with bronze, and objects thus prepared have come down to us, the iron having been preserved in its metallic state by its bronze covering.

The East Indian natives still prepare iron so excellently, though

their methods and appliances are of the rudest and simplest kind; and as we know that they have had this ability from before the time of Alexander the Great, it is probable that the use of iron was known quite generally at a very early stage of history. In the tombs of Thebes, which date about four thousand years ago, pictorial inscriptions are found which represent persons using iron utensils.

Iron is frequently mentioned in the Bible, and from the mention of the "frying-pan" in this verse from Leviticus vii. 9: "And all the meat-offering that is baked in the oven, and all that is dressed in the frying-pan, and in the pan, shall be the priest's that offereth it," and other similar passages, it has been supposed that the art of preparing sheet iron was known at this time. Though this is questionable, since the frying-pan used by the priest may not have been made of iron, but of some other metal, yet there can be little doubt that the Hebrews learned of the Egyptians the art of preparing iron from the ore, since an ancient mine worked by the Egyptians has been found in Egypt, at Hammauri, between the Nile and the Red Sea. The iron of this mine is in the form of specular and red ore.

Layard found iron weapons of various kinds at Nimroud, but they fell to pieces on exposure to the air. Iron is mentioned by Homer, and from what he says, it is inferred that it was scarce and valuable then, and that it was only as malleable iron that the Greeks of his time were acquainted with this metal.

In Sparta, however, Lycurgus is said to have enforced by law the sole use of iron as money, on account of its abundance. From Plutarch we gather an idea of the value of this iron currency, He tells us that it required a two-ox cart to carry a wagon load of the value of ten minæ; the value of a mina being estimated at about fifteen dollars.

Aristotle speaks in his works of the iron mines of Chalybia, and of their methods of working the ores. These mines were famous in antiquity, and from them was derived the term *chalybs*, given by the Greeks to steel, which has continued in use until this day, forming as it does the root of our term chalybeate water, for those waters which contain iron in solution. Strabo, who wrote about the commencement of the Christian era, speaks of the various iron mines then known, and among them mentions those of England, from which it is supposed that the native Britons understood the working of iron some time before.

Various other Latin writers mention iron. Pliny speaks of its

magnetic properties, but it does not appear from any such record that the ancients were acquainted with the process of making cast iron, or that their production of steel was anything else than accidental. This will appear more evident when we remember that they were totally unacquainted with any of the chemical processes of analysis in use to-day, and that their only method of industry was traditional and empirical.

During the first seven centuries of the Christian era we have but little record of iron making in Europe; yet in the sixteenth century the discovery of slag heaps in Sweden and Norway, in France and Silesia, and elsewhere, overgrown with trees, which examination proved were frequently six centuries old, showed that the mining and working of iron must have been extensively practised at an early age. Yet the process used in extracting iron from the ore was most probably a very rude one, and it was a long time before any improvements were introduced into it, and then they were diffused with the slowness which marked the dissemination of intelligence during those times when the methods of circulation were so tardy and inadequate.

The first production of cast iron took place in the fifteenth century, when larger furnaces were introduced. The first articles mentioned as being cast were guns, and in 1490 stoves were thus made in Alsace.

In 1550 George Agricola published his work *De Re Metallica,* which was the first modern treatise devoted to the manufacture of iron.

The high blast furnace is supposed to have been introduced by the Belgians. In England, cannon were cast by John Owen in 1535, and by Ralph Hoge in 1540, though the high blast furnace is supposed to have been introduced there only in 1558.

On the continent, with the improved method of blasting, it was found that the refuse heaps from the old Roman workings, and those of the ancient inhabitants, could be most profitably re-worked. Some of these supplies are said to have furnished material for the new furnaces for a period of two hundred years. In England the progress of the iron manufacture was more rapid. The iron was melted with charcoal as a fuel, until, in 1612, a patent was granted to Simon Sturtevant for the use of bituminous coal for this purpose. Next year another patent was granted for the same improvement to John Ravenson, and in 1619 another to Lord Dudley, who was so successful that his patent was taken away, and the

conservatism of his opponents prevented the use of his process, putting back the general introduction of this improvement for nearly one hundred years.

In 1784 a second patent, the first one being dated the year before, was granted to Henry Cort, for "shingling, welding, and manufacturing iron and steel into bars, plates, and rods, of purer quality and in larger quantity than heretofore, by a more effectual application of fire and machinery."

This was the invention of the art of puddling iron, for the invention of which Cort has been called the "father of the iron trade of the British nation," and the use of which is estimated to have, during this century, given employment to six million persons, and added $3,000,000,000 to the wealth of Great Britain. Yet Cort himself died poor, the government having involved him in law-suits, on account of his partner, which beggared him. The only restitution given him was a pension of one thousand dollars a year, which he received six years before his death, and which was reduced to six hundred and twenty-five dollars to his widow. In his experiments to perfect his process Cort had, however, spent from his private fortune over one hundred thousand dollars.

The next great improvement in the manufacture of iron was the introduction of heated air to the blast, which was first applied by Mr. Neilson to the Muirkirk furnaces. The date of this application is variously given by different authorities as 1824, 1827, and 1828. The patent for it, however, is said, upon the authority of a letter from the inventor himself, to have been issued in 1829. Neilson was more fortunate than Cort in obtaining the benefits of his invention. From a single infringer of his rights he received a check on the Bank of England for $750,000.

In his invention, however, Neilson used a separate fire for heating the air used in his blast, and thus the saving of fuel in the manufacture, though important, was not all that could be made. In 1837, M. Faber du Four, at Wasseralfingen, in Wurtemberg, introduced successfully a method for using the waste gases from the iron ore subjected to the smelting process, for the purpose of heating the air used in the blast, and also for generating the steam for the boiler.

The use of anthracite coal as fuel for the smelting furnace was tried as early as 1820 at Maun Chunk, Pennsylvania, but without success. In 1827–8 it was tried on the borders of France and Switzerland, at Vizelle. An account of these experiments may be

found in the third and fourth volumes of the *Annales des Mines*, in the third series of that work, and also in Johnson's *Notes on the use of Anthracite in the Manufacture of Iron.*

In 1833 Frederic W. Geisenhainer, a minister of Schuylkill, Pa., having experimented with the use of the hot blast with anthracite, obtained a patent for the process, and in 1835 produced the first iron so made.

In 1841 the process of consuming the gases generated in the process of smelting, was adapted to the use of anthracite by C. E. Detmold, and has since come to be used very generally in the United States, producing a saving of from two to three dollars a ton in the use of fuel.

The ores from which iron is obtained are various. Iron in its native state is rarely met with, especially when of terrestrial origin. Meteoric iron is not so uncommonly found, and is generally an alloy of iron and nickel. In the cabinet of Yale College is a mass of this composition, weighing 1635 pounds, which was found on the Red River in Texas. The meteors of this description are generally supposed to be portions of matter which are revolving in space, outside of our planet, but which, by the attraction of the world, are finally drawn to its surface. Though not of frequent occurrence, yet the numbers which have been found is very large.

The only place in this country where native iron, not meteoric in its origin, has been found, is in Canaan, Conn.; and as the precise locality cannot be designated, it is still a matter of uncertainty whether it has been thus found.

The iron ores are alloyed with sulphur, arsenic, or phosphorus. The first of these is a sulphuret of iron, and is called *pyrites.* This rock occurs abundantly in rocks of all ages, from the oldest crystalline to the most recent alluvial, and often in fine crystallizations, which, from their yellow color, are mistaken for gold. For its iron this ore is of no use, though its other compounds afford valuable materials for commerce.

White iron pyrites is a similar compound of iron, but its crystals are of a different form. It is called *Marcasite.*

Still another sulphuret of iron is called *magnetic pyrites.* It consists of about forty per cent. of sulphur and sixty of iron.

Leucopyrite, an arseniuret of iron, and *Mispickel*, a sulpharseniuret, are, as their names indicate, combinations of iron with arsenic and sulphur. They are both of common occurrence, but neither are of any value as iron ore.

Schreibersite, or phosphate of iron, is found only in the meteorites.

Specular iron is an oxide of iron, with two atoms of iron to three of oxygen. When pure, it consists of seventy per cent. of iron and thirty of oxygen. It is widely diffused, and has received many different names. The cost of working it prevents it being generally used.

Magnetic iron ore is a magnetic oxide of iron. It is the native loadstone, is widely diffused, and yields an unrivalled ore. It differs from specular iron in its crystalline form, in being magnetic, and in giving a black powder instead of a red one.

Franklinite is an ore of iron containing zinc and manganese. It may be considered both as an ore of iron and of zinc.

Limonite is a hydrated peroxide of iron, which, when pure, contains 85.58 peroxide of iron and 14.42 water. This ore, under various names, forms the coloring matter of so many stratified rocks, and is so universally disseminated through the geological formations, that it is more difficult to say where it does not exist than where it does.

Of the carbonates, phosphates, and arseniates of iron, the variety is very great, but the only important one, as an ore, is *Spathic iron*. This is a carbonate of iron, with 37.94 of carbonic acid, and 62.06 of protoxide of iron. It is almost never found pure, but contains manganese, and generally more or less alumina, lime, and magnesia. This is, perhaps, the most important ore of iron, not generally in its sparry state, but as a mixture with clay and the hydrated oxide which, resulting from its decomposition, and constituting a part of the great carboniferous formation, occurs, consequently, with the coal required for its reduction, and makes it of great importance.

The arseniates and phosphates are not ores, but on the contrary are highly injurious to the quality of those with which they are found occurring.

The manufacture of iron in the United States dates from a period very soon after the settlement of the country. From a tract entitled *A True Declaration of Virginia*, published in 1610, only three years after the successful settlement of a colony at Jamestown by the London Company, we find that in this year Sir Thomas Gates testified before the Council in London that in the country there were diverse minerals, especially "iron oare," some of which having been sent home, had been found to yield as good iron as any in the world.

From *A Declaration of the State of Virginia*, published in 1620, we find that among those recently sent out to the colony, there were "out of Sussex about forty, all famed to iron workes."

In his *History of Virginia*, Beverly speaks of an "iron work at Falling Creek, in Jamestown River, where they made proof of good iron ore, and brought the whole work so near a perfection, that they writ word to the Company in London that they did not doubt but to finish the work, and have plentiful provision of iron for them by the next Easter." This was in 1620. In 1621, three of the master workmen having died, the company sent over Mr. John Berkeley, with his son Maurice, with twenty other experienced workmen. On the 22d of May following, Berkeley, with all of his men, except a boy and a girl, who managed, by hiding themselves, to escape, were massacred by the Indians, together with three hundred and forty-seven others of the settlers. By this untoward event the manufacture of iron was stopped, and was not revived until about 1712.

It is a singular coincidence, and one which should modify our judgment of the barbarism of the Indians, that about the same time, in England, a mob destroyed the works erected by Edward Lord Dudley, for smelting iron ore by the use of coal in his process patented in 1621, and that this similar employment of violence put off the general introduction of this process for nearly one hundred years.

In a pamphlet written by Edward Williams, and published in London in 1650, with the title of *Virginia, more especially the Southern Part thereof*, etc., the author, speaking of iron, says, "Neither does Virginia yield to any other province whatsoever in excellency and plenty of this oare; and I cannot promise to myself any other than extraordinary successe and gaine if this noble and usefull staple be but rigorously followed."

To check too excessive attention to the raising of tobacco, which at the time ruled at very low prices in England, where it was sent to be sold, and to encourage the consumption of iron, and its manufacture into the various articles needed for their own use, in ship-building and other industries, the exportation of iron was, in 1662, prohibited, on penalty of ten pounds of tobacco for each pound of iron exported. This prohibition was removed in 1682.

With the enterprise for colonizing Massachusetts Bay, the Court of Assistants in London, who took an active part in this measure, contemplated the production of iron. The journal kept of the

proceedings of the court states that at a meeting held on March 2, 1628–9, "also for Mr. Malbon it was propounded, he having skill in iron works, and willing to put in twenty-five pounds in stock, it should be accounted as fifty pounds, and his charges to be borne out and home from New England; and upon his return, and report what may be done about iron works, consideration to be had of proceeding therein accordingly, and further recompense if there be cause to entertain him."

Three days after, an arrangement was made with Thomas Graves, of Gravesend, Kent, to visit New England, at the expense of the company, as "a man experienced in iron workes, in salt workes, in measuring and surveying of lands, and in fortifications, in lead, copper, and alum mynes."

On his part, Graves agreed to serve the company six or eight months for a free passage out and home, and five pounds a month with board. If he remained three years, the company were to transport his family, and support them until the next harvest, pay him fifty pounds a year, give him a house and one hundred acres of land, with a share in the land allotment; while any additional compensation was at the company's discretion.

Whether Graves, who settled at Charlestown, discovered any mines, does not appear. No steps were taken towards the manufacture of iron until fifteen years after this date.

In November, 1637, the General Court of Massachusetts granted to Abraham Shaw one half of any "coles or yron stone w^ch^ shall bee found in any comon ground w^ch^ is in the countrye's disposing."

At an early period, the bog iron ore, which is deposited in the peat bogs and ponds of Eastern Massachusetts, was discovered at Saugus or Lynn. These ponds, which are abundant on the seaboard of New England, are scooped out of the drift and tertiary formation; and at their bottoms, the water which has percolated through the surrounding hills of gravel and sand deposits large quantities of the sesquioxide of iron. This sediment, mingled with vegetable mould, and partially solidified by combining with the water, forms masses of soft and spongy bog iron ore, or crystallizes into a more compact hydrate. When this is removed, the deposit is re-formed, at intervals of time varying according to the impregnation with iron of the springs by which the ponds or bogs are formed. These deposits are quite frequent in the county of Plymouth, Massachusetts.

The necessity of iron for various purposes, and the difficulties

in the trade with England, led soon to the attempt to introduce the manufacture into the colony. In 1643 Mr. Bridges carried with him to England specimens of the ore from the ponds near Lynn, and, in connection with Winthrop and others, formed a "Company of Undertakers for the Iron Works." The sum of one thousand pounds was subscribed, and with this Winthrop, with a corps of workmen, returned to New England the same year. Others joined in the enterprise, and on March 7, 1663–4 the General Court granted them the exclusive privilege of making iron for twenty-one years, provided that within two years they made sufficient for the use of the colony. They were allowed the use of any six places not already granted, provided that within ten years they set up in each place a furnace and a forge, and "not a bloomery onely." The stockholders were exempted from taxation on their stock, their agents from public charges, and they and their workmen from trainings.

It has been questioned whether their first forge was set up at Braintree or Lynn, but Lewis, the historian of Lynn, avers that the first works were erected there, on the west bank of the Saugus, upon land purchased from Thomas Hudson, and near a chain of ponds abounding in ore. The village about the works was called Hammersmith, from the native place in England of some of the workmen. Operations were continued here with varying degrees of success for more than one hundred years, and the heaps of scoriæ about the place still mark the spot in which this important industry was commenced and carried on.

Not the least difficulty in the way of the successful working of the iron works established by the company was the want of ready money among the undertakers of the project, and also the want of money among the inhabitants to purchase the wares produced. The court, in reply to a letter from the proprietors in 1646, wrote, "If your iron may not be had here without ready money, what advantage will that be to us if we have no money to purchase it?"

In August, 1648, Governor Winthrop wrote concerning it: "The iron work goeth on with more hope. It yields now about seven tons per week, but it is most out of that brown earth which lies under the bog mine. They tried another mine, and after twenty-four hours they had a sum of about five hundred, which, when they brake, they conceived to be a fifth part silver. There is a grave man of good fashion come now over to see how things stand here. He is one who hath been exercised in iron works."

The company, in 1677, after having been several times sued for debt, succumbed to the force of adverse circumstances, and the property passed out of their possession into the hands of Samuel Appleton, who sold them about ten years after to James Taylor. The chief importance of the establishment of these works was, that they introduced the industry into the country, and brought over to the colony many skilful mechanics, the result of whose labors have not yet entirely disappeared.

Among the first workmen engaged at the foundery were Henry and James Leonard, who aided in making the first castings in the United States, and were the first of a long line of iron masters of their name who have been scattered all over the country. Joseph Jenks, of Hammersmith, near London, was another skilful workman who was connected with this undertaking from its commencement. Mr. Lewis, in his *History of Lynn*, says of him: "Joseph Jenks deserves to be held in perpetual remembrance in American history as being the *first* founder who worked in brass and iron on the western continent. By his hands the first models were made, and the first castings taken of many domestic implements and iron tools. The first article said to have been cast was a small iron pot, capable of holding about a quart. Thomas Hudson, of the same family with the celebrated Hendrick Hudson, was the first proprietor of the lands on the Saugus River, where the iron foundery stood. When the forge was established, he procured the first casting, which was the famous old iron pot, which he preserved as a curiosity, and handed down in his family ever since."

In March, 1739, Joseph Mallison, who was interested in the management of a furnace in Duxbury, memorialized the Legislature for a grant of unimproved land in consideration of his having introduced the use of sand moulds for casting hollow ware, such as pots and kettles, of which he claimed to be "the sole promoter, whereby the province saved annually at least twenty thousand pounds importations." This improvement he had made some years before, and the General Court, in acknowledgment of his claim, granted him two hundred acres of unimproved land.

The introduction of casting in sand instead of clay moulds has been ascribed also to Jeremy Florio, an Englishman, who practised it at Kingston.

Among the early settlers of this country, and during even the last century, many domestic utensils of iron, which are now to be met with in the humblest dwelling, were quite unknown, or else

highly prized for their rarity. The wills and inventories of persons who were among the well to do, frequently enumerate such articles as iron pots, and their entire stock consisted often of only one or two, and these were bequeathed to relatives or friends as marks of affectionate esteem. A century ago tea-kettles were made of wrought iron exclusively, and the rarity of cast iron vessels shows how limited was their production, even in England, from whence the supply was chiefly obtained. The plentiful supply of these conveniences at the present time is due chiefly to the introduction of anthracite in the place of charcoal for fuel in the furnaces.

In 1750, when the act was passed by Parliament for encouraging the importation from the colonies of pig and bar iron, and prohibiting the erection of any slitting or rolling-mills, plating forges, or steel furnaces, there were found to be in existence in the colonies two slitting-mills in Middleboro', one in Hanover, and one in Milton, as also a plating mill with a tilt hammer, and one steel furnace. The rolling-mills were chiefly employed in making nail rods, to be worked up by hand.

This account of the early growth of the manufacture of iron in Massachusetts, will serve as an indication of how the same industry became established in other of the colonies. To treat it with the same detail for each of the states would require too much of our space, and it is sufficient to remark that this industry was, at the time of the revolution, carried on to a greater or less extent in each one of the thirteen colonies.

An idea of the general character of the furnaces used in the last century can be best gathered from an account written in 1804 by Dr. James Thatcher, who was one of the proprietors of the Federal furnace, erected in 1794, in Carver, a town seven and a half miles from Plymouth, and which is printed in the Massachusetts *Historical Collections*. At the time this description was written, pig iron had about ceased to be produced in this country, but the blast furnaces were in operation for casting. Ten forges were also employed for making bar iron from scraps and old cast iron, to the extent of about two hundred tons annually.

The furnace was about twenty feet high above the hearth, and eight feet wide in the boshes. The blast was produced, as was then usual, by two bellows, twenty-two feet long and four wide. These were driven by a water-wheel twenty-five feet in diameter, and worked alternately. Every six months two or three blasts, of

sixteen or eighteen weeks each, were made, producing about three hundred and sixty tons of hollow ware, with other articles, the whole estimated at about 1200 pounds a ton. The cost was: —

2130 cords of wood, making 1420 loads of charcoal, at $2.50,	$3550 00
726 tons of ore, at $6, ...	4356 00
Two sets of stones for hearth, ...	153 32
Wages of founder, at $1 a ton, ...	360 00
Wages of other workmen, ...	2331 00
Total	$10,750 32

This furnace produced also iron cylinders for slitting mills, potash kettles, stoves, fire backs and jambs, plates, gudgeons, anvils, large hammers, cannon balls, and a great variety of machinery for mills.

With the war of the revolution, the legislative interference of Parliament with the industry of the colonies ceased. It was this narrow-sighted policy of interference which had forced the colonies to appeal to arms, after having exhausted every method of peaceful protest, and reasonable attempts to vindicate their rights. During the continuance of the war, the increased demand for iron in the manufacture of weapons, and for domestic consumption, together with the total stoppage of all foreign supply, caused a great increase in the production, and led to the successful inauguration of many branches of manufacture. The general congress and the local state legislatures recommended to the people that greater attention should be paid to the development of the natural resources of the country, and encouraged many branches of manufacture by bounties.

At the close of the war, many kinds of industry which had been stimulated by the previously existing unnatural condition of isolation, and by the attendant legislation, were ruined by the importations of cheaper products from Europe; and, under the then existing confederation, there being no harmony or uniformity of action between the states, their conflicting legislation, actuated by narrow and selfish views of their individual, instead of the general interest, produced such a depression of commerce as made it evident that a better political organization must replace the old confederation.

Fortunately, however, the war had strengthened, instead of weakening, the convictions of the people in the necessity for freedom in their political relations, and intensified their wise jealousy

of too much governmental interference with their individual conditions for social, political, and industrial development. They had been trained to self-reliance, and desired to be citizens, not subjects; to be members of a commonwealth, and organize a government for their own purposes, to be their servant, not their master.

Especially fortunate was it that, at the same time, the financial policy of the government was in the hands of Alexander Hamilton. The credit of the government was destroyed, its circulation was almost worthless, and being without any national traditions, with no organization of the national service, the crisis looked grave, and it needed a man with a mind comprehensive enough to embrace the necessities of the case, and with a logic sure enough to see that by the industry of the country alone could the stability of the new nation be assured, and that the duty of the government was to foster and direct, not to control and hamper, the play of the energies of those to whom it owed itself, its existence, and authority.

If ever at any time an attempt upon the part of a government to interfere with the natural development of industry was justifiable, it was just at the period succeeding the revolution. Not only were the circumstances at home such as would seem to call for governmental protection, but the course of the mother country was such as would seem to have justified it as a measure of retaliation.

By an act of 1785, Parliament prohibited, under severe penalties, the enticing of artificers or workmen skilled in the iron and steel manufactures out of the British kingdom, or the exportation of any tools used in these arts, and also all machinery, engines, or parts of such, or all models or plans of such.

Hamilton's report upon manufactures, as Secretary of the Treasury, and his suggestions for the protection of those branches which required it, is an admirable document for its careful and temperate tone. But it was chiefly to his administration of the treasury, his introduction of order and method into this department of the public service, to which all industry must be subservient, and to the freedom of our political relations which fostered the enterprise of individuals, that the wonderful growth of our industry during this century is due. Labor was taught to depend more upon itself, its energy, and its ingenuity, than upon governmental protection; and, as the history of almost any special

branch of industry will show, it is to these qualities that American industry owes its successful and independent character.

During this century the iron manufacture has steadily increased, though its progress has fluctuated in consequence of the changes in the tariff. Yet American industry has contributed its share to the improvements in the methods of manufacture which have been detailed above; and the furnaces of the United States will compare favorably with those of any country for their appliances to attain excellence and economy in the process of manufacture.

One of the most important improvements in the manufacture of iron has been introduced by some of the founderies of the West, and consists in the welding of cast iron. This is done by pouring molten iron on the edge of the shaft, or other fractured surface to be mended, until it becomes melted, and then, the mould being closed, the needed part is cast upon it. This most important discovery is entirely American.

The chief improvement of late date is that known as the Bessemer process, which is described in the article upon STEEL. Perhaps it is not too much to say that, by this process, in due time, the whole method of manufacture will be changed, and the increased demand of our growing industry be supplied at much cheaper rates than we have yet seen. The last suggestion in the process is the use of the spectral analysis of the light from the combustion of the gases from the furnace, as a test of when the decarbonization of the ore has been carried to the desired point. Thus the most delicate and accurate discoveries of pure science are found to be the allies of the rudest industry.

SAWS, AND THEIR MANUFACTURE.

SPECULATIONS AS TO THE ORIGIN OF THE SAW. — THE GREAT PART IT PLAYS IN CIVILIZATION. — SCRAPS OF ANTIQUE HISTORY. — THE INVENTION OF THE SAW ASCRIBED BY THE GREEKS TO DÆDALUS, OR PERDIX, EMINENT SCULPTORS WHOM THEY DEIFIED. — THE SAW AMONG THE ANCIENT EGYPTIANS. — DESCRIPTION OF THE EARLIEST KNOWN SAWS. — BECKMANN, EMY, HOLTZAPFFEL, KARMARSCH, WRITERS UPON THE SAW. — APPLICATION OF WATER, WIND, AND STEAM AS MOTIVE POWERS OF THE SAW. — INTRODUCTION OF SAW-MILLS INTO ENGLAND VIOLENTLY OPPOSED BY THE PEOPLE, AND THE MILLS RAZED TO THE GROUND BY THE MOB. — SUPPRESSION OF MILLS BY ACT OF PARLIAMENT. — REVIVAL OF MILLS, AND INCREASED DEMAND FOR SAWS. — THE SAW IN THE UNITED STATES. — PROCESS OF MANUFACTURE. — THE CHIEF MANUFACTORY OF THE UNITED STATES. — THE KEYSTONE SAW, TOOL, STEEL, AND FILE WORKS. — BIOGRAPHICAL NOTES ON MR. HENRY DISSTON, THE EMINENT FOUNDER OF THE KEYSTONE WORKS.

THE saw has ever played a most conspicuous part in the economy of manufactures, and its importance will readily be admitted, when we consider how essential a bearing it has upon our every-day life, and how conducive it is to the development of those useful arts upon which, to a great extent, the very existence of civilized humanity depends. Its extended and universal employment in the higher class of industrial art has, in great measure, contributed to the advancement of civilization and prosperity, by administering to the production not only of those things which are necessary to our being, but of those which tend to cultivate the taste and to refine the mind. The art of sawing must have been known at an exceedingly remote period (even, it is probable, in prehistoric times), as it is impossible to suppose that such magnificent and gorgeous structures as are described in the Hebraic Scriptures, and elsewhere, could have been formed without some knowledge of the use of the saw; but the full extent to which that knowledge existed, and the modes of its practical application, cannot be educed from the insufficient

evidence at our command in these times. The ancient Greeks ascribed the invention of the saw — as also the chisel, compasses, and auger, with other implements — to Dædalus (or, as some say, Talus), or his disciple Perdix, renowned architects and sculptors, who were accustomed to employ these instruments in the production of the Dædali — wooden images of the gods, ornamented with gilding and real drapery, and usually represented standing with the feet in an advancing posture. There is every reason to believe, however, that the derivation of saws is infinitely more remote, as they have been discovered clearly represented in the midst of the hieroglyphics inscribed on the obelisks of Egypt. According to the hypotheses of sundry ancient writers, the jaw-bones of the snake with its teeth, or the vertebræ of a fish with its protruding small points, first suggested the plan of the saw; but it is equally as likely that a common brier upon which some antique "genius" may have torn his flesh, or his fig leaves, if he wore any, may have suggested the idea. The great wonder is, so useful an implement is the saw, that we have not been assured by some ancient writer that the notion of the saw was divinely inspired. The Greeks did indeed deify the supposed inventor of the saw, thus intimating that, in their opinion, the conception of it was beyond the powers of the human mind.

The saws used by the Grecian carpenters were made like the straight frame instruments of modern days, the blade having been set across the middle of the frame, with the teeth perpendicular to the plane. The block of wood was held down upon a table or bench by clamps, and the sawyers, on opposite sides of the bench, at each end of the saw, pulled it back and forth.

The investigation of the history of the saw affords an interesting field to the archæologist, although the materials or means of information are limited, so far as specific facts are concerned; but there is wide scope for intelligent inference. But such investigation, thoroughly carried out, and the results thereof stated, would hardly come within the purview of this article, which is intended in the main to be utilitarian. Those who desire to make more extended researches, are referred to Beckmann's "History of Inventions," containing an account of the earlier saw-mills, together with certain speculations on the origin of the saw. Emy, in his "Traité de l'Art de la Charpenterie," also makes some allusions to the same subject of an instructive character, as likewise does Holtzapffel, in the second volume of "Turning and Mechanical

Manipulation," and Karmarsch in the "Handbuch, der mechanischen Technologie," vol. i. Hanover, 1866.

Saws are made of the many forms and sizes required by thousands, according to the particular purposes for which they are designed; and hardly any instrument for man's use is more varied in size than the saw, when we consider the full range of its species, so to speak, from the watchmaker's delicate saw for piercing and inlaying, which measures about one thirtieth of an inch in width, and one hundredth of an inch in thickness, up to the immense mill and mulay (mullet?) saws in use in certain portions of America, and the peculiar band-saws in combination with rack-benches, employed in ripping logs of timber of almost any dimensions.

The oldest forms of the saw are made of a straight piece of steel, "toothed," and set in a frame, or with handles on either end, to be moved by one or two persons, according to the form given; or the saw-plate is made sufficiently stiff to be propelled by one handle, and worked by a single person holding it in one hand, like the saw most in use among joiners and carpenters in general. In modern times has been invented the circular saw-blade, which revolves, and with its teeth in the periphery, may be made to cut with incredible speed; a saw of two feet in diameter, for example, being driven at the speed of from two thousand to twenty-four hundred revolutions a minute.

But the chief important improvement, for a long time, relating to saws, is one recently devised by Mr. Henry Disston, of Philadelphia (and patented January 14, 1868), which, since it comprehends one of the most valuable achievements of progress, in any art, namely, economy of means or in products, is highly worthy of note. To make this great improvement most clear to the reader, it should first be observed that the rapid wear of circular saws demands the frequent sharpening of their teeth; and that this, in ordinary saws, not only requires tedious manipulation, but results in the rapid reduction of the saw in diameter. To rescue the saw from this rapid reduction is the object of Mr. Disston's successful invention.

The better to explain this great improvement, we introduce the two accompanying cuts, designated "Fig. 1" and "Fig. 2," respectively. (For the use of the plate of the latter we are indebted to the courtesy of Messrs. Henry Disston & Son, of Philadelphia.) Fig. 1 represents a portion of a circular saw with or-

dinary teeth, which must be sharpened by reducing both the front edge *a* and back *b* of each tooth ; a duty which requires much time, and which cannot be performed without much waste of material, as will be readily understood by reference to the dotted lines, which illustrate the condition of the blade and waste of material after frequent sharpening.

Fig. I.

To obviate these objections or difficulties was devised the plan above alluded to, and shown by Fig. 2 (on next page), by which it will be observed that the back of each tooth is a continuation of a curved line, Z, spirally arranged on the blade, and that the sharpening of the tooth is accomplished by the reduction of a portion of the front or throat only ; thus, in reducing the tooth, the course pursued by the cutter (the contrivance by which the tooth is cut) is spiral, so that while the rotary cutter is in the act of reducing the front of the tooth, D, it is at the same time prolonging the back of the tooth, C, prior to the reduction of the front of the same.

The teeth can be sharpened from time to time, by simply filing the bevelled ends (as seen in Fig. 2) ; and this mode of sharpening may be continued until the bevelled point of each tooth reaches nearly to the end of the throat, when by means of a rotary cutter a further portion of the throat may be removed.

Fig. 2 (representing the so-called "Patent Gullet-Tooth Circular Saw," secured by patent to Messrs. Henry Disston & Son) further illustrates, in its double capacity, a saw, B, as worn down from a larger saw, A, the teeth having been "carried back," or cut (by the use of the same firm's patent "gummers"), on the periphery lines, Z, instead of on the centre line, G, by the old method of filing. The engraving represents a two inch tooth or gullet. When the saw has been worn down by this method from C to F, on centre line, it has been reduced but six inches, but has presented a point or cutting surface on the periphery line from G to Y, a distance of twenty-four inches. The majority of saws, however, are run successfully with a one and one-fourth inch tooth ; and of course the smaller the gullet the less the waste of the saw.

Anterior to the adaptation of mechanism to the saw, large timber

was universally converted through the agency of the pit or whip-saw. This instrument varies in size from about six feet to eight feet in length, and is furnished at the upper end with a tiller, and at the lower with a box to adapt it to the hands of the sawyers. The balk, or beam, after being sorted and lined out by the converter, is then placed over the saw-pit, in order that the saw

Fig. 2.

may be used in a vertical position by two men, called, respectively, the topman and the pitman. The men are favorably stationed so that their positions shall enable them to give the saw a nearly perpendicular traverse of three or four feet; but in the up-stroke it is withdrawn a few inches from the end of the cut, so as to allow the sawdust free escape, and likewise to avoid blunting the teeth.

It is customary, when deals or expensive woods of moderate dimensions are required to be sawn, to make use of the pit-frame saw, which is much thinner than the whip-saw, and therefore less wasteful of the material. The saw is attached to a wooden frame of a parallelogrammic figure, by means of two iron buckles or shackles riveted to the blade, and arranged so as to embrace the top and bottom cross-heads of the frame. The lower buckle is cleft for the insertion of a pair of equal or folding wedges, the office of which is to draw the saw-web stiff and tense, and retain it in proper position.

We clearly have in this apparatus the germs of the saw-frame, and mill-saws, and it only required popular demands and sufficient time to perfect them into the varied and complete instruments of the present day. We cannot fix the exact date at which saws by other than hand force first came into operation, although it may be affirmed, on reliable authority, that mills driven by water-wheels and the wings of wind-mills existed in Germany as early as the fourteenth century. They subsequently made their way in a very crude state into Germany and Holstein. Towards the close of the year 1596, a saw-mill worked by water power was erected at Saardam, in Holland. Saw-mills were not introduced in England prior to the seventeenth century, on account of the prejudice existing against them on the part of sawyers, who, like many members of various handicrafts, repulsed any innovation likely to interfere with their trade, and lessen, as they maintained, their means of subsistence. In fact, so high arose the antipathy and obstructiveness of the sawyers, that Parliament was obliged to pass a law to appease them, whereby the use of saws driven by wind or water power was prohibited. For this reason, a mill erected by a Dutchman near London, in 1633, was abandoned. Nevertheless, in spite of this stubborn opposition, efforts were not wanting, persevering ones, and another mill, impelled by the force of the wind, was built in Limehouse, by a Mr. Houghton, in the year 1760. Unfortunately, this only served to arouse in a still greater degree, the rage of the populace, who ended by throwing the mill to the ground, and demolishing the entire works.

Efforts to introduce the water or wind mills, were suppressed from that time for a period of about sixty years, when an opulent and enterprising merchant, encouraged by the Society of Arts, caused a wind power saw-mill to be erected again at Limehouse, under the

supervision of an able and experienced millwright by the name of Stansfield, who had learned in Holland and Norway the art of constructing and managing works of this nature.

The attempt proved, however, as futile as those that had preceded it. Crowds of the disaffected once more mustered around the building, and under the guidance of two or three desperadoes, irretrievably destroyed it, and ruthlessly scattered the *débris.* It is satisfactory, however, to add, that the government came forward, and indemnified the spirited *entrepreneur* for the loss he sustained by this flagrant act of injustice. It is a pitiful fact in the history of the arts, and sciences, — and the remark may be justly extended so as to embrace matters of agriculture and commerce as well, — that governments do not, far more than they have ever done, interest themselves in projects which are calculated to advance the general well-being of their respective bodies politic, and to succor individual enterprise. The tendency of the age is to coöperative enterprise. This is emphatically the age of guarantee, of mutual insurance, and united effort — the palpable precursor of those days of enlightenment which are to succeed civilization, in which shall be witnessed no more such violent struggles as we record above between impoverished labor struggling in its witless way to preserve food for its hungering mouth against the suggestions of genius attempting to lessen the general burdens of labor for humanity, and pushed on by capital. The war between labor and capital must ever continue, till an intelligent, inventive genius, equal to that which prompts and perfects the mechanical enterprises of individuals, is brought to bear upon the improvement and reorganization of that old machine which has so clumsily run on for the ages, ever getting out of repair, often violently checked in its course, and making fearful counter-revolutions, — breaking its shafts, with ever a "screw loose" here and there, and sometimes tottering, and swaying, and breaking down with a crash of war and its attendant wrongs and horrors, and which miserable machine we are wont in its parts to call "Government," "Society," — semi-developed, or further advanced, and which, with a general term, we curiously enough name "Civilization."

Shortly after the destruction of the mill which we note above, another one was erected in its place, and was permitted to flourish unmolested; and in a few years the general establishment of mills

in the vicinage of London followed as a corollary. Beckmann asserts that a saw-mill of a most *outre* description, had been in action at Leith, in Scotland, some time antecedent to those erected about London.

To General Bentham is commonly accorded the honor of having been the first to apply steam as a motive power for driving saw-frames; and in a patent taken out by him in 1793, a machine of this class is specified for operating on wood, previous to its conversion into scantling for "block shells," etc. Since then, great progress has been made in this branch of mechanical industry. Iron and steel have supplanted wood for constructive details, thereby, as English manufacturers assure us as the result of their experience, insuring greater stability and superior work, as well as conferring a simple and more elegant appearance upon the whole structure; while, at the same time, ample strength and solidity are provided to preserve it free from vibration and fracture. But in this country wood as a constructive material largely continues to find favor with sawyers, who maintain that its elasticity absorbs or counteracts the vibration of the saws, cutters, etc., and that thereby higher rates of speed may be attained than would be consistent with iron and rigid frame-work. But the writer's observations lead to the contrary opinion, and practical Englishmen, who speak from experience, assure him that iron and steel are found preëminently qualified for the purposes of erection, and are, as well, greatly superior to the softer and more yielding material, by reason of the greater durability and freedom from inherent decay.

It was the application of water, wind, and steam, as motive powers, to the saw, which created that large demand for its use which has characterized the nineteenth century over all its predecessors, and which extended its operations into many thereto untried fields of enterprise; and for the perfect operations of the saw, as perfect settings or frames as may be, are necessary. Indeed, the saw and the frame are only necessary and co-operative parts of a whole, and must go together — as essential to each other as teeth to the masticating animal man, or as the man to the masticating teeth.

The introduction of the saw into America was coincident with its settlement, the saw at that time being as feeble and simple, as an instrument, as were the colonies as bodies politic — and as out of small beginnings has grown one of the foremost nations of

the world, so equally has the science of the saw in its mechanical improvements and manufacture grown until to-day, when in the United States the best saws of the world are made. The capital invested in the manufacture of saws in this country is many millions of dollars, employing large numbers of artisans.

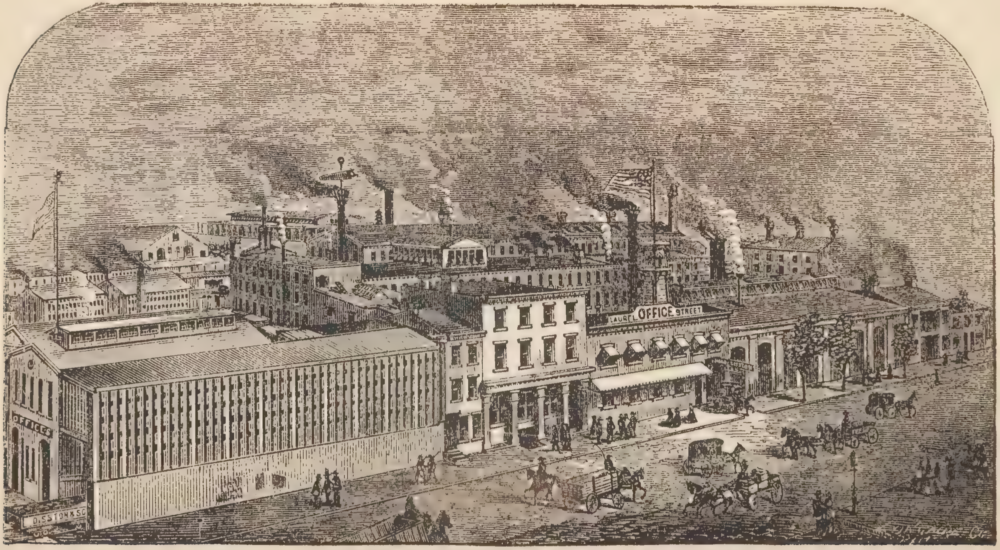
The process of manufacturing saws may be described in a few words. An ingot of steel is prepared, from which the plates are to be manufactured, and being heated to a requisite heat, is placed under a ponderous steam hammer, and subjected to severe manipulation, which tends to refine, densify, and toughen the grain of the steel; it is then re-heated, and placed under powerful rollers, and flattened out to the required thickness, and thereafter cut up into slits if need be. The edge intended for the teeth is then made true by trimming, and the plate is next taken to a toothing machine, a fly press, suitably provided with punches, regulated by gauges so that a suitable and uniform distance apart may be secured for the teeth, and then the plate is "toothed" rapidly. The punch or "die" leaves somewhat rough edges to the teeth, which edges are, as the next process, removed by files, and the teeth sharpened. The blades are next made to undergo the hardening or tempering process, which consists in their first being heated in large ovens, over an intense fire, to a red heat, whence they are withdrawn at a certain degree of heat, and plunged into vats containing oil, together with certain ingredients, such as resin, tallow, and bees-wax, in certain proportions. Of the precise proportions of these, together with anything like a minute description of the tempering process, it would, in every case, be difficult to assure the reader; for the art of tempering, especially in instances where it is a peculiar success, is kept a secret in the temperer's own bosom. By this process the blades acquire great hardness; and he now subjects them to a new heat, until portions of the oil not wiped off begin to burn. This latter process is known as "blazing off." The temperer regulates the degree of hardness according to the purpose for which the given saw is intended. That the stiffness of the plate may be uniform throughout, it is next hammered thoroughly upon a large anvil: this is called, in manufacturing parlance, "smithing." The next step is to grind the plate, so that it shall, commencing at a given thickness of teeth, grow slightly and gradually thinner to the back (or to the centre, in case of circular saws). The process of grinding was exclusively, till of late, that of placing the plate upon a stiff board for a back,

and pressing one side of it at a time against a grindstone; but in the leading establishment in the United States, the "Keystone Saw, Tool, Steel, and File Works" of Philadelphia, Pa., the grinding of saws is to a large extent done by a patented process, by which the plate is ground on both sides at once, with far more uniformity in regard to thickness, as well as more expertly and economically than when ground on one side at once.

After the saw is ground, it is taken back to the anvils for re-"hammering," in order to take out whatever distortions may have occurred by the pulling and friction it has received in grinding; then back again to the grindstones, where it is "drawn," as it is called. It is now ready for the "glazing" or polishing process, which being done, it is carried back to the anvils once more to be straightened, after it is "grained" with emery, after which it is set. It is next passed through the process of stiffening, or having the requisite "spring" or elasticity given it, which is done by a heating process. After it comes from this process, and is cooled off, whatever discoloration it may have received from the process of heating, or otherwise, is removed by acid, and then it is oiled. (At this point devices or names are etched or stamped on the saw.) It is now ready for sharpening, which done, it is "handled" (if of the kind needing handles), and is inspected, and then packed for market.

The most extensive, and without doubt the best manufactory of saws in the United States, and probably in the world, as the writer is confidently assured by one whom he deems to possess a larger knowledge of the saw and its manufacture than almost any other person living, is that of the world-famed "Keystone Saw, Tool, Steel, and File Works," established originally by Mr. Henry Disston, whose name is known throughout the world wherever a saw is used.

The process of manufacture at the Keystone Works is substantially as described in the general description above; but it should be remembered, in honor of the intelligence that is made to bear upon the manufacture of saws at this establishment, that many of the details of the several processes are the inventions of Mr. Disston and his associates, and are secured to them by letters patent. These, in good measure, enable them to outvie other works in the accuracy of their manufactures, as well as in their cost of production. The Keystone Works successfully compete in all respects with foreign manufacturers, and in some respects sur-



KEYSTONE SAW WORKS; HENRY DISSTON & SON, PHILADELPHIA.

pass them. For example, the so-called "No 7" saw, manufactured by these works, is said by the best authorities to be worth forty per cent. more than the best English saw.

And here, in the not illaudible pride, we trust, of Americans in our victories over other countries, especially in the "contests of peace," it is our great pleasure to note the following evidence of an American triumph not only over English skill, but that of the whole world in the matter of saws. Mr. Disston, some time in 1867, forwarded a circular saw blade to the great London dealers, Messrs. Holloway & Co., and received from them a voluntary and appreciative testimonial in the letter below, which we have been permitted to copy.

"London, England, Nov. 23, 1867.

"Mr. Henry Disston.

"Dear Sir: You will be pleased to learn that your circular saw blade reached us yesterday safely. We have tried it to-day, and it is more than all we expected of it. In every respect it is the best saw we have ever seen, and its equal cannot be produced in Europe. We beg to thank you for all your kind attention to our wishes, and are your obliged and obedient servants,

"Holloway & Co."

A testimonial like the above, and so well merited, should satisfy the professional ambition of any manufacturer in the land. It may be noted here that the Keystone Works frequently receive perhaps equally good testimonials of the perfection of their wares, in the shape of large boulders cut entirely through by their saws without breaking the latter, which boulders have by some means become imbedded in the huge trees of California or Oregon, it may be, and which as cut in twain, are forwarded to them by some admiring sawyer; and in the largest iron saw-dogs cut completely in two by their matchless saws.

The Keystone Works not only manufacture all kinds of saws, from the common wood and hand saw up to the largest circular saws ever made, inclusive, — mill, mulay, gang, cross-cut, drag, pit-saw, patent combination saws, etc. — but also do a large business in setting, sharpening, gumming, and hammering circular and other saws for other establishments which have not the requisite facilities, and also do their own (silver or gold) plating, and plate for others. It should not be overlooked that they make,

for their own consumption, the steel ingots they need for their saws, etc., after a perfect and patented process; and it is due greatly to this fact that their saws take precedence of all others.

Their establishment is immense, covering over eight acres of ground, and employing upwards of six hundred laborers. They pay always over nine thousand dollars per week, the employees receiving from six dollars per week for boys, who do the lighter work, to thirty and one hundred dollars per week for skilled workmen. Before our late civil war, wages averaged about one-half of what they do now. Workmen at the same trade in England get about one-half of what the Keystone Works paid before the war. The prices of the saws made by the establishment remain about the same as before the war, the superior and patented machinery of the Keystone Works enabling them to manufacture to such excellent advantage.

Mr. Disston, the founder of this establishment, is a strong advocate of "protection," as against free trade, and believes that the success of the works, and the lucrative employment which it has been enabled to give to its large number of employees, providing thus for hundreds of families, have been secured by the protective tariff, as well as by the eminent care and skill exercised in the manufacture of its wares.

Not only does Mr. Henry Disston stand pre-eminent in this country as the successful pioneer in the manufacture of saws, but his career is one of marvellous successes, secured through great intelligence, by untiring perseverance and the conscientious fulfilment of professional duties; and a short biography of this eminent manufacturer can be fitly made here, as instructive and encouraging to the earnest young men of the country.

Mr. Disston is an Englishman by birth, but came here at an early age, and is an American in sentiment and active energy. He commenced business in a small cellar in the vicinity of Second and Arch Streets, Philadelphia; and the first coal he ever used for the purpose of hardening and tempering his work was wheeled by himself from Willow Street Wharf, nearly a mile distant, to his little workshop.

The manufacture of hand saws had already been attempted by other parties, all of whom, however, failed, and it was reserved for Mr. Disston to establish that important and useful branch of industry in this country. But this was not accomplished without many severe trials and struggles, and in order to prove to

the merchant that he was determined to compete with the foreign market, he was frequently compelled to sell his saws at an advance of only one per cent. over the cost of production.

At the age of eighteen years Mr. Disston became foreman of the shop in which he served his apprenticeship, and was frequently the recipient of presents from his employers for the improvements he made in machinery, tools, etc. At this time it was the custom to send back to England all the scrap or waste steel made in cutting out saws, for the purpose of being re-manufactured into sheets. On this material there had already been paid a duty of thirty per cent., in addition to freights and other charges. The same steel, after its re-manufacture, would be returned to this country, and again subjected to duties and charges. This told so heavily against the American manufacture, that Mr. Disston determined that such a state of affairs should no longer exist; and about twenty years ago he commenced to make waste steel into ingots, which he caused to be rolled into sheets for the manufacture of the cheaper qualities of goods. The experience and confidence thus gained have proved to be of immense benefit, and although millions of dollars had been vainly spent in trying to produce sheet steel in this country, yet when our civil war broke out, and gold commenced its upward flight, Mr. Disston assumed the risk; and a success more flattering than his most sanguine hopes had pictured has crowned his efforts, the works now producing upwards of thirty tons of sheet steel per week, the whole of which is consumed in the establishment. The finest qualities are made into saws, which far excel those of foreign manufacture.

One of the great secrets of Mr. Disston's success is his practical knowledge of every department incident to the manufacture of saws. There is not a process, even the most minute, through which a saw passes from the crude and raw material to its finished state, but what can be successfully accomplished, in a mechanical point of view, by Mr. Disston himself.

In the year 1846 Mr. Disston removed his small establishment, and rented a room in the factory of Mr. William Miles, then situated on part of the site of the present works. In 1849 he was unfortunately burned out through the explosion of Mr. Miles's boiler — a disaster which might have cost him his life, as he was thrown a considerable distance by the concussion, but fortunately without sustaining any serious personal injury.

This event caused him to take up a small lot adjoining, sixty by one hundred and fifty feet, on which, in the short space of fifteen days, his first factory, thirty by sixty feet, and four stories high, was erected, and formed the nucleus of the present immense establishment.

As the rapidly increasing business demanded, it has been from time to time enlarged, until it has assumed its present colossal proportions — covering an area of over eight acres.

Mr. Disston now enjoys the laudable pride, as one reward of his great industry and professional ambition, of witnessing all the operations incidental to the making of saws of every description carried on here on a scale of unsurpassed magnitude; and not only saws, but all their constituent parts, together with all machines and tools used in their manufacture, are planned and fashioned within the works.

Mr. Disston may indeed be classed as one of the celebrated men of this generation. Born in England, in 1819, he came to this country at the age of fourteen years, in company with his father, who died three days after their arrival in Philadelphia. Friendless and without means, with no one to advise or guide his youthful steps, he was indeed a stranger in a strange land.

After many trials, vicissitudes, and struggles with poverty, he bound himself apprentice to the saw-making business, believing that the manufacture of saws was destined, at no very distant future, to become one of immense importance in a young and rapidly-growing country abounding in almost trackless forests of lumber, and where new cities rise up as if by magic. The forethought and shrewdness which at that tender age seemed to guide him in the selection of a trade, fully developed themselves in after years, and combined with great energy of character, have placed him at the head of the saw-manufacturing business in America, and perhaps the world. The labor market of Europe has been carefully scanned, and the most skilled and experienced workmen obtained, without regard to cost. The beneficial effects of this enterprise are now becoming visible, as some of the finest workmen in the world owe their efficiency to the instruction received in the "Keystone Saw, Tool, Steel, and File Works," of Philadelphia.

ORNAMENTAL IRON WORK AND BRONZE CASTINGS.

THE WORLD'S PROGRESS OVER IRON. — IRON THE CHIEF "PRECIOUS METAL." — FIVE DOLLARS' WORTH OF IRON IN ITS CRUDE STATE CAPABLE OF RECEIVING A VALUE, THROUGH ART, OF TWO HUNDRED AND FIFTY THOUSAND DOLLARS. — IRON SPOKEN OF BY THE EARLIEST WRITERS. — A SLIGHT PICTURE OF THE DESOLATE STATE OF MANKIND, SHOULD IRON BE STRICKEN FROM AMONG "THE THINGS THAT BE." — IRON IN ITS STAPLE USES, AND CONSIDERED AS A MEANS OF ORNAMENTATION. — ITS USE FOR THE LATTER PURPOSE IN EUROPE. — ORNAMENTAL IRON WORK IN THIS COUNTRY. — BRONZE CASTING IN EUROPE. — SUCCESSFUL COMPETITION WITH THE SAME AT LAST ACHIEVED IN THIS COUNTRY. — THE REPRESENTATIVE HOUSE IN THE UNITED STATES FOR ORNAMENTAL IRON WORK AND BRONZE CASTINGS, ROBERT WOOD & CO., OF PHILADELPHIA, PA.; MR. ROBERT WOOD THE FOUNDER.

THE progress of civilization may be said to be over iron; for iron is not only a column upon which civilization rests, but literally lies along the road, like rails, upon which it moves; and there can be nothing more pleasing to the student of the arts, or the lover of humanity who is interested in the material elements, which, commingled, add so much to human happiness, and without which misery only would be the normal condition of the races, than the subject of iron in its million ramifications. Notwithstanding the customary classification or nomenclature, iron is the chief precious metal. It can be made, even for the most delicate purposes, many fold more valuable than gold. A piece of iron worth but five dollars in the market in its simple state, may become, it is said, when combined with a proportion of carbon, varying from one-half to one and a half per cent., as steel, and wrought into balance-springs for watches, worth two hundred and fifty thousand dollars. By no process could five dollars' worth of gold in the ingot be wrought up to such a value, especially for practical, mechanical, or other possible purposes.

Indeed, in the study of iron and its uses, along the line of his-

tory, the student finds much which is sublime as well as beautiful. With the very heart of the races is iron blent — in fact, it courses in the life-blood or spirit of the races, as truly as it mingles, as the physiologists tell us, in the life-blood of the individual man. In the fourth chapter of the Genesis of the Hebraic Scriptures, which is one of the oldest, if not the oldest, of historical writing, we find even the "the artificer of iron" was the noted character or genius of his time; and in the eighth chapter of the book of Deuteronomy of the same Scriptures, we are told of "a land whose stones are iron." So, from the very beginning of historic times, iron has been a precious metal indeed to man. Every particle of gold and silver might be destroyed, and except in a few chemical preparations, useful in the fine arts, their absence would not be practically felt by the world. Even the world of beauty would not appreciatively lose its gems; for iron in these days can be wrought into as many beautiful shapes as gold and silver, and the pigments in the hands of the chemic-artist may be made to supply their fast colors or shades, while adding colors, too, as beautiful as their own, and which they cannot be made to imitate.

But take away the gift or blessing of iron to man, and a moral chaos would ensue, equal to the physical one of which Milton sings, and falling in its horrors and gloom but little below that which the most poetic geologist, in his rapt moods, is wont to picture, when brooding upon the "birth of creation." Not only would the nations be obliged to revert to the lowest forms of civilization, but so long and in so many countless ways have mankind been in the habit of depending upon iron as an essential means, in some form or other, of securing their daily happiness, and of conserving their best interests as well, that in the revulsion which the sudden withdrawal of iron from human goods would cause, a lower depth than the old barbaric life would be their fate — "confusion worse confounded;" for iron is as essential a "staple" as bread, and the teeming races of the earth without it, would be at a loss how to create the grains from which the latter is made, and starvation to millions on millions must ensue; and the earth might witness, in densely-populated countries, the dreadful spectacle of thousands of the hardly living feeding upon the carcasses of their dead brothers. In fact there are no bounds too great for possibility, which the picturing imagination can reach, when contemplating the subject in this light.

But even were not such a dreadful state reached at once, yet all progress or development would be arrested ; commerce would pall under the ruins of the wares upon which it thrives, and the fleets of the world fall to pieces in mid ocean, or crumble along the docks. All manufactures must cease, — all travel be suspended, and the travellers themselves imprisoned in herds in their own temporary homes, and in a short time find themselves naked, without further means of re-dressing than had Adam and Eve ; for without the iron or steel needle, they would want even the means, not only of keeping clothes upon their limbs, but the clothes themselves. And such as, perchance, should catch some lower animal for food, would be compelled to tear its flesh with their teeth and hands. Far more desolate and fearful to contemplate would be the condition of men now, if suddenly deprived of iron, than anything which in the past the world has witnessed. Next to air and light, iron is a necessity to man, since it in some way helps him to work out all his other goods. And without these, what would even the air and light be worth to the denizens of the temperate zones in particular ? — and in these zones crowd the vast majority of the races. The astonished world would, in short, stand aghast, and each man, in his utter impotence, with uplifted hands inquire of the other, " What *shall* we do to be saved ? " — not from the perils which may environ a future of this life, but from the demoniac starvation, and the countless possible diseases which must come rushing in the train of such a revulsion of the wheels of present progress, as it bears along the vans of civilization.

Thus little of iron in its staple uses for man as regarding its employment in the wares of every-day use ; in the plows which cut the furrows in which grow the grains for man's consumption ; in the hoes with which the army of weeds and tares is kept from stifling the growing cereals ; and in the rivets, bolts, nails, and bands which hold the parts of those plows and hoes together ; and in the knives, and draw-shaves, and lathes by which their wooden parts are shaped ; in the axles upon which even the grindstones, which sharpen these domestic weapons revolve ; in the means by which the motive powers, the horses and cattle which work the plows are joined to it ; the whiffletree hooks, the harness buckles and chains. But it is useless to attempt to recite in detail the forms which iron takes, and the necessities which it supplies, even in the basilar stratum of civilization. But there is another need of

man than that which simply supplies the wants of the stomach, and protects against cold or heat. The love of beauty is one of the chief elementary impulses to his progress; and iron, as a substance out of which countless ornamental devices are wrought,

Iron Fountain.

plays as large a part in the advancement of man's moral nature as it enacts in his physical preservation and well-being, and is far more capable of serving the multitudinous purposes of artists than are the miscalled precious metals. Besides, iron is a cheaper substance than those, and in this respect more available for the purposes of beauty, administering to the delight of a vaster number of beholding eyes than they; adorning more households, more public buildings, parks, streets of cities, in brackets, and balco-

nies, and posts, and mouldings, and turrets, etc., etc., than could all the other "precious metals" combined, to say nothing of its ten thousand other uses.

In the older countries, in many portions of Europe especially, is everywhere seen in altar railings, gates, and gateways, palisades, fountains, and in other forms, gorgeous even, many of them, the wondrous skill of the blacksmith's art — greatly the creations of other centuries; and the exhumations of Pompei show that no mean skill in the blacksmith's field of art was exercised nearly two thousand years ago among the Roman races. In fact, it is impossible to note the time in the history of the art when the element of beauty did not enter into more or less of the blacksmith's work. And, indeed, to such heights has this art been carried, that out of iron have been called forth the most exquisite representatives of the tendrils, sprigs, and leaves of daintiest flowers, — vieing with those wrought with even the braided gold of Malta, — as well as the most elegant and slender twisted columns sustaining great weights, and mounted with volutes more beautiful than any which can be cut from stone by the subtlest art of the sculptor. And the art of ornamental iron work of elegance and great merit is not confined to the hammer of the blacksmith, but is seen in the foundery as well.

In the United States, the use of iron for architectural purposes has been carried to a great extent. Immense capital is invested here and there, over the country, in the manufacture of iron into houses, and various ornamental work for the same, as well as for the fencing of public parks and cemeteries, and private grounds. Indeed, so extensive is becoming its use for ornamental purposes, that nearly every village in the Eastern and Middle States, containing a population of five thousand inhabitants, boasts its little foundery, or its machine shop, or smithery, where ornamental iron work is made; or, lacking these, has its depôt for the sale of ornamental iron fabrics of some kind. And the art is now as well understood in some portions of the country as in Europe, — though it must be acknowledged, that the higher grades of work are yet mainly made by artisans of foreign birth and rearing, imported here by American manufacturers; but the genius of the American mind is fast accomplishing the mysteries of the art.

Much of the work which now emanates from American shops compares favorably with the very best of the middle ages work of Europe in all respects, and is given to the public at cheaper rates, thus

carrying the comforts and solaces of a fine art into a large number of houses and homes which could not afford to enjoy them at the prices which ruled for the imported wares before American enterprise entered this field of iron ornamentations. In excellence of workmanship, flowing lines, graceful curves, and that exquisite "touch" of high art which cannot be told in the printed line, and which only the engraver's art can fitly illustrate, and which is always so necessary to the perfection of any creation of the high arts, American artisans have become, in the manufacture of ornamental iron work, equal to the best of the old masters. The iron railings, for example, which some of these manufacturers produce vie with the palisades of the king's tomb in Westminster Abbey; and their spiral staircases equal, in graceful convolutions and facial ornamentations, the famous water-tower of the Crystal Palace — while other of the stairways are fully equal, in scope and proportion, as well as grandeur, to the grand *Scala* of the Farnese Palace at Rome. And in the more aerial styles of the art, so deftly formed of iron wire, and wrought into a thousand ornamental shapes for counters, office railings, window guards, flower vases, and every conceit which human ingenuity has devised for human comfort, and to administer, at the same time, to the love of beauty, perfect success has been achieved — so much so, that the art of making ornamental iron work may be said to be as truly a solid business of America, as is the growing of tobacco, or the building of railways. Greater amounts of ornamental iron work are made in this country now, and distributed to a greater number of people, than are made and sold, perhaps, to domestic purchasers in all Europe.

A visit to one of the manufactories of those wares well repays one. The leading manufactory of the country is situated in Philadelphia, Pa., and is the property of Robert Wood & Co., who, as manufacturers of twenty-five years' standing, may be called the pioneers of the art in this country, as well as the representative manufacturers in their line. The perfect character of their work for so long a time has left them no real competitors in the field, though they have many imitators; and it is a pleasing phase of the American character, which the writer is happy to diverge to notice here, that whenever real merit has made its mark and taken the vanguard in any pursuit, all engaged in like pursuits, however much they may quarrel with each other, are ever ready to acknowledge it — so, everywhere is it that the

house and works of Robert Wood & Co. are the boast and pride of other ornamental iron workers.

The same house has of late years added to its ornamental iron making another branch of art, which in some respects may be said to be a kindred one, in which, however, they have less imitators, and may be regarded as standing almost alone in this country. In fact, when considering the variety of the work which they have accomplished under this head, as well as the perfect success they have attained therein, it may be said that they stand alone — and this branch is the casting of life-sized figures, single and in groups; of animals, together with the pedestals upon which they are placed, and plinths, and columns, which add so much to the charming effects of garden scenery and landscape art. These are modelled on the best copies of the antique; and the wealthy man of taste may decorate his grounds with everlasting ornaments which would have graced the gardens of the Hesperides — a delight to himself, and pleasing attractions to every eye. Sharp, clean copies of the famous Warwick and other vases are produced by this house; and they also accomplish everything beautiful in the line of garden chairs, settees, and fountains, together with complete summer houses, in a profusion of styles to satisfy the taste of the most critical and fastidious.

BREVOORT VASE.

It should not be overlooked, in an article like this, that in the line of ornamental iron work, made for the pleasure as well as use of man, may be comprehended many things made for the use of man's chief servants among the lower orders of animals — the horse and the cow; and these articles take upon them

more or less fanciful shapes. The matter of stable furniture and fittings, such as elegant racks, neatly-moulded mangers and troughs, unique posts for stalls, rings, peculiar devices for insuring cleanness to the favorite beasts, as well as to administer to their general comfort, is by no means an unimportant branch of iron work, and in the factory of Messrs. Robert Wood & Co. has received the best-merited attention.

Bronze statuary is a branch of art which is legitimately united to that of ornamental iron work, in the uses of conserving beauty to which it is put, and in the founding-phase of its construction; and it fell naturally to the lot of the house of Robert Wood & Co., after having achieved their leading successes in America in the line of ornamental iron work, to undertake its manufacture in this country. With larger facilities for accomplishing such work than are possessed by any other house in the United States, as the writer is confidently assured, while there is but one other house which attempts it, it was not to be wondered at, that with all their experience in administering to the love of beauty, or taste, and the excellent skill which their time-old workmen had for more than a score of years attained in the modelling of hard substances into exquisite forms of beauty — that this house should have at once, on entering upon it, carried the art of bronze statue-making on to a complete success. Their reputation as accomplished artists in this line of work has, in the short space of five or six years, become not only commensurate with the bounds of the country, but has reached the ears of sculptors and designers in Europe.

It is proper here to note, that the colossal bronze statue of Lincoln, which stands on Union Square, New York, was cast by Messrs. Robert Wood & Co. Whatever critics may think of the modelling itself of the statue, there the statue stands, a proud evidence of the skill which took it from the designer's hands in its crumbling materials, and gave it perpetual life in bronze — a triumph of American art of which every American should be proud, so far as the work of the founders is concerned. The ill or good taste of the designer, Brown, the sculptor, can neither detract from nor add to the merits of the founders. Hitherto, till of late, it had been believed by many wise in their ethnological studies and observations, that we, as a people, were not old enough by a century to accomplish such work; but thanks to the enterprise and faith of these founders, the work has been accomplished in a style which is not surpassed by the world-famous founders of Munich.

A chief importance of bronze statuary among the historic and decorative arts is, that when it is properly composed and scientifically cast, it resists the deteriorating action of the elements, and gains, with time, that sombre dignity which is its artistic peculiarity; while statues cut from the finer stones are apt to deteriorate rapidly when carried into other climates than that in which are situated the quarries from whence their materials were taken. The bronze statuary is also less liable to fracture, and, if injured, can be restored to its original brilliancy. The ancients understood this, and bronze statuary flourished in the highest civilization of the Greeks and the Romans. The famous Apollo Belvidere of the Vatican Museum at Rome, though a marble statue, is evidently only a copy of a bronze figure. The preference must, for various reasons, be given to statuary in bronze over that in marble; and in view of the remarkable progress in public favor which the plastic art has made in the United States within the last few years, nothing can be more pleasurable to note than this great triumph of casting bronze statuary in perfection.

Ward's "Soldier of the Seventh Regiment," a figure measuring a few inches over ten feet, and which stands in the New York Central Park, is from the foundery of Robert Wood & Co., and, like the statue of Lincoln, does honor to the house.

The vast expense which leading manufacturers in ornamental iron work, and especially founders of statuary, incur annually, would surprise the uninitiated; but there is not space in this article to notice it in detail. Suffice it, that the making of new patterns and designs alone is an item of extreme cost; and the people at large should be grateful to the enterprising manufacturers who afford them wares at such comparatively cheap rates.

Robert Wood and his Establishment.

The establishment of Robert Wood & Co. eloquently illustrates that great results may be obtained by aptitude to business, strict integrity, and unswerving perseverance. Mr. Robert Wood, the originator of the great firm of Robert Wood & Co., has been in business only about thirty years, and is now (1871) in his fifty-fourth year. Mr. Wood was a poor boy, and began life as an ordinary blacksmith, in a little one-story shop in Ridge Avenue, in Philadelphia, which shop occupied a portion of the site of the extensive ornamental iron and bronze works now owned by Robert Wood & Co. At that time, most kinds of scroll and iron ornament-

ning Star.

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MRS. EMELINE BURLINGAME-CHENEY.

dunno as I ever heard any on ye say much as tew whether it was amusin' or not. It was a blessed duty, an' brought more pure joy than a day of revelry. Some on ye, even now in this age, don't let yer right hand know what yer left hand doeth, an' you lug food off unbeknownst tew sufferin' old neighbors."

Here Deacon Hazzard blushed and sighed heavily. Evidently he had been watched. Stopover continued:

"An' didn't ye git more pure joy out of sich deeds than ever came from worldly enjoyment? I think so, an' the diffikilty with the age is that we are bringin' religion down on the plane of worldly amusement. Lemme tell ye the world'll beat ye every time. We can't make a church raffle as interestin' as a pool room. We ain't got the facilities, though a New York minister advocates a church bar-room. We couldn't have the picters on the walls, or the marble nymphs behind the bar. Ef we attempt tew fight the devil with his own weapons we git our hands burnt with his trident. We may see the day when we shall advertise that the minister and his church clerk will dance a double clog at a church social, but the world will be 'way ahead with an opera with a score of living pictures. We have got a cook-shop and restaurant for chicken dinners in the basement of our church, but the world beats us at that with a stage an' a 'English Gayety Girl.' The church is gitting like our modern flyin' machines; we can't git the wings big enough tew lift the machinery. We've got a society m

Devotional.

IS IT TRUE?

Is it true, O Christ in heaven,
That the highest suffer most?
That the strongest wander farthest
And more helplessly are lost?
That the mark of rank in nature
Is capacity for pain?
And the anguish of the singer
Makes the sweetness of the strain?

Is it true, O Christ in heaven,
That, whichever way we go,
Walls of darkness must surround us,
Things we would but cannot know?
That the infinite must bound us
Like a temple veil unrent,
Whilst the finite ever wearies,
So that none's therein content?

Is it true, O Christ in heaven,
That the fullness yet to come
Is so glorious and so perfect
That to know would strike us dumb?
That, if ever for a moment
We could pierce beyond the sky,
With these poor dim eyes of mortals
We should just see God and die?

—*Helen Hunt Jackson.*

TALKS ON EVERY-DAY TOPICS.

IV.

CONCERNING OUR FRIENDSHIPS.

BY OLIVE E. DANA.

One of the wisest bits of advice that

he might forever be thinking humbly of himself and be tempted to higher things."

It seems to be impossible for most of us to make such choice of associates, and equally impossible that God should not have some gracious purpose in the destiny that forbids it. Perhaps one is that we may see our companions on their largest side, and may learn to know the heroism, the patience, the single-mindedness, the great-heartedness that may be accompanied by very meager intellectual capacity. And we may be surprised to find how these outweigh, when time holds the scales, all lesser gifts. It seems to me that this habitual perception of the essential greatness or nobility of character is one of the rarest and most compensating of attainments.

It is in our fulfilment of its nobler demands that friendship makes known its exactions, shows its high ideals, and gives us its sweet rewards.

It has its prohibitions, forbidding not only petty criticism, espionage, neglects, jealousies, but little injustices, slights, and demands which the very intimacy of acquaintance should make us hesitate to ask. What it may be our friend's delight to grant, or even to offer, it is not our right to ask. And it ought not to be necessary to add that no familiarity or warmth of feeling can justify the habit of unthinking criticism, unjust or inadequate statement, or petty fault-finding. The kindly pointing out of faults may be allowable, yet many a friendship beside that of Gil Blas has been wrecked in this wise.

The real friend will be very careful that his friendship, or hers, does not even seem to cross the orbit of any closer relationship. There are bounds it ought never to pass, and, be it small or great in itself, there is a proportion that, for love's sake, it must help to

the treatment of that delegate. He who has said, "Touch not mine anointed, and do my prophets no harm," will not hold him guiltless who shall from personal spite or mere malice ill treat one who has given his life to the preaching of the glorious Gospel.

Young men who are contemplating the ministry very often halt in their decision and hesitate in their determination because "in everything" to-day the ministry is "blamed." Unless he feels the "woe" strongly upon him the young man hesitates to enter an occupation where every man is his critic and every person his self-appointed sponsor. An ambassador is accountable to the government sending him, not to every individual member of the body to which he is sent. Young man, if God is calling you to the ministry, he is calling you to the highest and most sacred work ever given to man. To be a true ambassador of Christ is the highest office the world has ever known or that heaven has ever sanctioned. If you he is calling, go forth strong in the glory of your ambassadorship, and as men receive you they receive the God who sent you; as they treat you they treat the Christ who commissioned you; as they deal with you so shall they be dealt with in the day when they shall be rewarded according to the deeds done in the body. Christ in sending out the twelve said, "He that receiveth you receiveth me, and he that receiveth me receiveth him that sent me." There is no office higher than that of ambassadorship; anciently an ambassador ranked next to the blood royal, now is the ambassador of Christ clothed with an authority regal and supreme—his office the highest and noblest by God ever created, higher than that of the angels themselves, for not even they are permitted to preach the good tidings to them that sit in darkness great.

al work were made by hand, of spelter and zinc. True genius is never at rest; it is always aspiring. No matter if the emulated "goal" *be* reached, — beyond it ever lies an "excelsior;" and Mr. Wood conceived the design of a foundery for casting such ornamental work from iron, believing that such work only would meet the growing public want, and with his great energy went forward to put his conception into practical working, achieving at last, though step by step, each wisely taken, the great successes which have made this establishment the leading house of its kind in America.

Among the large number of the employees of this house are comprised some six designers, constantly at work, and believed to be second to none in the world. These artists, in a measure, give tone to the establishment, securing the perfection of beauty for its work — a thing essential to the success of such a house, however worthy for faithful and substantial work it might be. The chief difficulty which Mr. Wood and his partners have ever had to contend with, is the procuring of skilled workmen enough to accomplish their extensive orders. Making it a rule of their business career — from which they never swerve — not to let an article of slighted or imperfect workmanship go out of their establishment (although in thousands of instances purchasers would declare themselves satisfied with less meritorious work), they have found no little trouble in securing employees of sufficient skill, in several branches of their work. About two-thirds of their workmen have served their apprenticeships with them; and these, continuing with them, make a strong available force. The other third are mostly foreigners, and are more or less migratory in their habits. But not unfrequently some new device calls for its execution a greater number of skilled hands than are at the time available. But gradually this trouble is being overcome. The firm pay their laborers always fair wages, and so never suffer from so-called "strikes" among their men — a fact which has proved advantageous to the firm, and might well be imitated by employers in every branch of industry and art.

It is not the purpose of this article to note the mode of founding even the bronze statuary, — which this firm is the first in America to bring into successful competition with that of the founders of the old world, or to note the processes of their iron work, — for founding is a process which is elsewhere in this book sufficiently described for the general reader's information. Suffice it

that Messrs. Wood & Co.'s foundery and ornamental iron works are complete in their several parts, for the ends which each is designed to accomplish ; that their bronze foundery contains an air furnace capable of melting three tons of bronze at once ; and that a large fireproof "pattern-building," of three stories and a basement, in dimensions, barely suffices to hold their patterns, though packed away with the greatest regard to economy of space, and the reader may fill out for himself the idea of the magnitude of the establishment over which Mr. Robert Wood, the once poor boy, now one of the recognized substantial men of the great city of Philadelphia, presides — a man upon whom the good William Penn would have cast approving smiles, could he have looked through the "horoscope of the coming days" down to these times ; for it is to such men as Mr. Wood that the solid wealth and happiness of Philadelphia are due.

And while the writer of this article is noting the value to their respective communities, as well as to the world, of such intelligent mechanics as Robert Wood, he cannot forego the gratification of recording a pleasurable fact which he noticed, while visiting the great establishment of Robert Wood & Co. The power used in the establishment is steam. The engine and the engine-room are kept marvellously clean by the engineer, who reigns here supreme, keeping his iron gateways locked against all. Even the proprietors must ask his consent to enter, so careful and laudably rigid in their rules are the firm. Master of all, and secure as Cyclops in his cave, here the engineer rules in his perfect apartments, and has fitted up for himself bath-tubs, and a book-case filled with choicest works, and a writing-table, at which he finds much time to devote, — showing that literary tastes are not incompatible with mechanical pursuits, and thus tending to elevate the latter.

BILLIARDS AND BILLIARD-TABLES.

BILLIARDS. — A NATIONAL GAME. — BILLIARD TABLES. — THE EXTENT OF THEIR USE IN THE UNITED STATES. — THEIR INDUSTRIAL AND COMMERCIAL IMPORTANCE. — THE MORALE OF AMUSEMENTS CONSIDERED. — THE COMPARATIVE MERITS OF BILLIARDS. — THE PSEUDO-MORALISTS, AND THEIR FALSE POSITIONS. — THE NECESSITY OF SOME RELAXATION FROM SEVERE LABOR. — THE OPPRESSED CLASSES. — THE OLD ROMAN AND THE EGYPTIAN SYSTEMS OF AMUSEMENT. — CHESS AND BILLIARDS COMPARED. — THE ORIGIN OF THE GAME. — ITS SUPPOSED INTRODUCTION FROM PERSIA INTO EUROPE. — THE KNIGHTS TEMPLARS IN THEIR CONNECTION WITH BILLIARDS. — THE GAME NURSED IN THE MONASTERIES OF EUROPE. — LOUIS XI. AND HENRY III. OF FRANCE, MARY QUEEN OF SCOTS, AND QUEEN ELIZABETH, GREAT PATRONS OF BILLIARDS. — SHAKESPEARE AND BILLIARDS. — THE MANUFACTURE OF BILLIARD TABLES. — THE VAST FACTORY OF THE LEADING MANUFACTURERS OF BILLIARD TABLES, MESSRS. PHELAN AND COLLENDER, OF NEW YORK. — THE PARLOR BILLIARD AND DINING TABLE. — MR. MICHAEL PHELAN AS AN ARTIST, MANUFACTURER, AND INVENTOR.

THE game of billiards may properly be said to have become a national one in the United States, exercising no small influence in moulding the morals of our people, and evoking a manufacturing and commercial enterprise hardly second to that which the *piano-forte* creates. In almost every village of two thousand inhabitants, and, indeed, in many with less population, a billiard table (with usually an accompanying one) is to be found in some public house, the favorite hotel, or the most elegant "saloon" of the village; and here and there numerous "village lords," emulating the elegant amusements of the rich denizens of cities, boast their private billiard-rooms, and their favorite tables; while throughout the larger towns and cities of the Union, from the capital of Maine to the remotest southern and western boundaries of the republic, billiard tables are found in large numbers; and, as the game constantly increases in public favor, so, in consequence, the number of billiard tables multiplies at a vigorous rate. That the game gives strength to the muscles when temperately and wisely in-

dulged in, and bestows upon the mind at the same time a healthy discipline, while its fascinations are so great as to give a charm to its pursuit, not a few, who would otherwise spend their time in gambling-houses and liquor-saloons, and cultivate therein pernicious and destructive habits, cannot safely be denied.

It is hardly within the purview of this work to discuss the moral bearings of any industry, or its adjuncts, upon which it discourses. The history of an art, together with the means and modes of manufacture of the wares which it creates, constitutes the chief object of this work; but it will not be out of place, in an article upon a matter of so great importance as billiards and billiard tables, to give some consideration to the question of morals therewith. It may, in the first place, be safely remarked, that so long as the low standard which civilization at the best has only attained, so that labor in all its branches, labor necessary both to human existence, *per se*, and to the healthful well-being of the race, remains unattractive to ninety-nine hundredths at least of the world's population, some mode of amusement, more or less worthy, more or less temperately or intemperately exhilarating or recreating, will prevail, in spite of all the mawkish philosophy of morals which the anchorites and cynics may disseminate in the way of fragmentary reforms, or by attempting to subdue the proclivities of man to freedom from excessive burdens, in the field of amusement and playful relaxation. The healthful infant in his cradle even, and especially when he has obtained the skill to creep, usually expends more of vital power in proportion to his general strength, and consumes more of his muscular fibre, in his gambols, than does the adult workman expend of his in his daily labors; yet we call the infant's labor or exercise "play," and speak of the workman's as "toil," wearisome, onerous, exhausting. The infant's "labor" is full of cheer; that of the workman pitiable indeed, especially when long pursued. The difference in these two instances would seem to lie in the fact that the labor of the one is attractive, desirable, healthful, and prompted by nature; that of the other distasteful, undesirable, not healthful in the best sense, and artificial; for the same means are used to accomplish the one and to perform the other. Here, then, is a matter for the consideration of the social philosopher — how to so organize the labor forces of the world, or a given community, that the labors of the adult yeoman or artisan shall become as genial to them as are those of the infant to itself. Until

some intelligent effort shall be made by the self-elected "moralists" and social philosophers of the world to solve the problem of such an organization of society, in connection with its industrial forces, as shall make the tilling of the soil, and manufacture of all possible wares, as attractive and congenial to the laborer as is the reading of books, for example, to the scholar, the petty philosophers and preachers, and the fragmentary reformers, will "prate, and prate on," to but little purpose. The general good sense of the people is superior to their philosophy, even though the latter be clothed in the dignified solemnity of the Puritan, or wear the soft graces of the purely religious enthusiast.

But on the subject of "morals," properly speaking, as related to the game of billiards, it might be tersely said that this amusement is already without the pale of discussion; for "morals" properly imports no more than "custom," as its etymology distinctly shows, it being derived from the Latin *mos* (gen. *moralis*), which means only *custom*. Whatever, in short, is customary, generally permitted, or in use, is in itself "moral;" and if not conducive to the well-being of a given "society," cannot be said to be destructive of the same, since it is but the legitimate outgrowth of such society itself.

But in civilization, as it is with its countless unattractive forms of labor, whatever system of political economy does not embrace some hours of daily relaxation, and certain methods of amusement, is a false and pernicious idolatry of Mammon, having man's best energies and happiness as the victims to be sacrificed upon its unholy altar.

There are two extremes of population, especially, in which the sanitary uses of amusements are apt to be overlooked, and their consideration, as needs of humanity, expelled by the so-called "sterner" necessities of life. Where the population is so dense as we find it in some portions of Europe, especially in the manufacturing districts of England, not a moment can be spared from the incessant demands which competition ("the life of business," but the death of all that is best and noblest in the individual contestants and strugglers) makes on labor. Labor is so redundant there that it loses its proper value, and nothing but strictest and most unremitting devotion to business can secure even the barest necessaries of life; yet this is but a sad fact in the "Christian civilization" of one of the most elevated nations of the earth, nineteen hundred years after the Founder of the new religion or

the "sublime heresy," which broke upon the Jewish world and the old faith, as a new, enlightened, and startling revelation of the King of kings from out of Nazareth, — nineteen hundred years after that Founder first announced to his followers, as the law of their moral and economical polity, that they should "take no thought for the morrow" as to "what ye shall eat, or what ye shall drink, or wherewithal ye shall be clothed;" evidently intimating in this the coming of a time, and the practicability of the life thereof, when the general good will of the Christian world should be such that no individual need take greater care for the morrow's needs than does the beloved little child in the home of his loving parents. How little has the moral standard of the world advanced meanwhile! When wealth is monopolized in the hands of a few, while the millions are forever hovering on the brink of starvation, it would be absurd to look either for a general diffusion of intelligence, or for any system of amusement superior to that afforded by the rum-shop, the dog-fight, or the lower scenes of the "prize-ring," which kind of amusements the oppressed classes will have when unable to procure better.

On the other hand, where the population is disproportionally small, when compared with the large resources which lie around it, in a new and undeveloped country, where wealth lies unenjoyed, or runs to waste on every hand for want of labor to collect and garner it, — where every man is, in a sense, his own master, and is free to create a future for himself independent of others' aid, — in such a condition of society toil rises to unnatural importance; time is then reckoned not by hours, but by dollars; and hence it is we find that in the earlier settlement of the United States the grim, puritanical spirit of the original immigrants into the eastern portion of the land in particular, not only discouraged "unprofitable amusements" (meaning thereby anything which moved the spirit to aught but serious thought and rigid economy) by preaching and denunciations from the pulpit, and long and bitter homilies at the fireside, but went so far as to prohibit innocent recreation by penal enactments.

This short-sighted policy revealed great ignorance of man's real nature; for the desire for pleasures exists in man, as well as in the lower order of animals, as an innate instinct, prompting to the most important purposes. It teaches the child the use of his various faculties, inspires him with ambition, and gives him dexterity; and in manhood it is one of the best promoters of bodily

health, and so strengthens the mind as to enable it to sustain those serious toils which, unrelieved in some way, would succeed in degrading all mankind to that level which, alas! is the supreme height of too many of our fellow-mortals — that of mere human machines.

True wisdom would seek to encourage the desire for pleasures, and direct it into such channels as would best promote the objects for the accomplishment of which we were endowed with it by nature; and true policy would suggest that instead of following a plan of amusements like that of the old Romans, in which the public games embraced the mortal struggles of the gladiators, and deadly contests between wild beasts and men, we should rather adopt the older Egyptian system, whereby the public recreations were made the vehicles of imparting all the most scientific truths, in a form so agreeable and simple, that the merest intellect was enabled to appreciate and store them up. Thus the original game of cards, as taught by the builders of the Pyramids, conveyed a knowledge of the whole system of practical astronomy — the "court cards," as they are now called, representing the different constellations which rule the year, and the numerals being marked in such a manner as to indicate precisely the different periods for the overflow and subsidence of the Nile, and the various agricultural operations dependent thereon. But cards have long since lost their character of primitive simplicity and instruction, and degenerated to far different service, though still valuable, in some degree, for the arithmetical combinations which they illustrate. But it is generally felt that they are fraught with peril; and that they do not encourage that bodily exercise, without which amusements fail to be healthful, is true.

The splendid game of chess, which may be denominated a tournament of intellect, and which affords a field for the development of the highest efforts of genius, is, for the reason that it does not exercise the body as well as the mind, so serious a game that it fails to be an amusement proper. It often exhausts the brain-power; and the most noted victors in its field have been forced to shun its fascinating, though destructive, enticements. It is too rigorous and concentrated to be suited to the general intellect.

But we have not space herein to dilate at greater length upon the comparative merits of various amusements; suffice it that no amusement is precisely suitable for man, unless, in the first place,

it exercises and disciplines the faculties, and calls upon the resources of both the body and the mind, without wearying the one or disgusting the other ; and, in the second place, the amusement should contain within itself sufficient mental excitement to keep up the spirits without the stimulus of extraneous inducement to pursue it, such as bets of money. The game of billiards (so appears to be the popular testimony) answers the requirements of the above twofold rule.

The precise origin of the game of billiards is involved in that obscurity which enshrouds a great portion of the inventions, etc., of antiquity. The speculators, rather than historians, who have written upon the subject, universally agree that billiards of a crude nature was an antique game ; although it must be admitted that as a scientific employment, affording an exercise of the most pleasing kind, and natural to both the mental and physical energies, the game of billiards is a modern invention. By some writers it is held that the game was imported into Europe from Persia during the consulate of the Roman Lucullus ; while by others its introduction (from the East) is ascribed to the Emperor Caligula, during the first half of the first century of our era. But be this as it may, there is no authentic record of its existence until the return of the Knights Templars to Europe, on the termination of the first crusade, in the early part of the twelfth century ; so that, if known at all to the Romans in the days of Caligula, it must have perished, along with many other arts, on the overthrow of the empire ; and unless the excavators of Herculaneum and Pompei shall exhume the remains of a billiard table, the matter of Roman understanding of the game must forever remain a subject of uncertain speculation. In all probability, however, the game, like that of chess, is of Eastern origin. When the Templars brought it back with them from the Holy Land, it soon became the favorite amusement and means of health to which the cloistered monks of that period were permitted by their superiors to have recourse ; and however much it came to be regarded as a "carnal amusement" in later times, we have abundant evidence that it was cradled in the monasteries, which were the fountain heads, or at least the chief depositories, of the Christian faith. But games so introduced by the Templars shared their fate, and disappeared along with their fortunes ; and it was not revived again until the peaceful disposition of Louis XI. of France (about the year 1445) induced him to prefer its pleasing strifes to the bloody tournaments

which were then the pastimes of his court. One of his successors, Henry III., largely patronized the amusement, and from him it received the appellation of "the noble game." Further on, we find that Mary Stuart, Queen of Scots, complained in a letter to the Archbishop of Glasgow, and written the very evening before her death, that her "billiard table had just been taken away from her as a preliminary step to her punishment." Mary, having been married to the Dauphin of France, was probably introduced to the game during her stay in Paris. Doubtless, too, Queen Elizabeth was a passionate votary of the game, as well as her beautiful cousin Mary; and with this suggestion can we alone explain the anachronism which Shakespeare commits when he makes Cleopatra (Antony and Cleopatra, Act II. Scene 5) exclaim to Charmian, "Let us to billiards!" for beyond question, we think, this was one of the compliments to the caprices and habits of his royal mistress with which the great dramatist was wont to interlard such compositions as he wished should find favor in her eyes.

Before dismissing the matter of the history of billiards, it should, perhaps, be added, that the early history of billiards indicates a number of games which had been called by the same appellation. Some of them were played on the ground, others on elevated platforms and tables, — the latter of various shapes, round, square, oval, and oblong. The accessories, it would seem, were more varied than the tables; and among other things we read of iron arches, miniature castles, churches, and other buildings, figures of men and animals which, as well as balls and pins, were placed on the table.

As has been before remarked in this article, the manufacture of billiard tables in the United States is a matter of great industrial and commercial importance — a fact which we cannot perhaps so well illustrate otherwise, as by taking the reader with us through the extensive and completely appointed works of the leading manufacturers in this country (and, as we believe, in the world), the Messrs. Phelan & Collender, of New York. There are several extensive manufactories in the United States, each doing a good business financially, and producing more or less worthy wares. It should be noted here that in no other country is the game of billiards so extensively practised as in the United States, and probably nowhere else can be found so many great experts in this fascinating art and healthful recreation.

For the purpose of obtaining an insight into the mode of manu-

PHELAN AND COLLENDER'S WORKS, TENTH AVENUE, NEW YORK.

facturing the tables, balls, cues, etc., the writer visited the billiard manufactory of the Messrs. Phelan & Collender in the latter part of 1870, and there took notes for the purposes of this article.

Their new and admirably appointed warehouse, at 738 Broadway, New York, is five stories in height, and covers a ground area of twenty-five feet wide by one hundred and six in length ; the first and second floors being for the business offices and warerooms, the third for the ivory room, and the fourth for the stock room.

The manufactory of Messrs. Phelan & Collender is in 10th Avenue, extending from 36th to 37th Streets, the grounds being one hundred by two hundred feet in area, and the building being five stories high, amply supplied with light on all sides, and commanding from the upper stories a fine view of the Hudson River for miles. The factory is specially adapted for its manufactures, and furnished with the best improved machinery and tools, and has a capacity for the employment of about one hundred and twenty men, comprising about a dozen different classes of expert mechanics. From seven hundred to one thousand billiard tables are here made in a year, besides an immense amount of balls, markers, cues, etc., the value of stock on hand being usually about $100,000. The value of the billiard tables varies from one hundred to one thousand dollars each, according to size and style of finish ; and the amount paid by the proprietors during the last year in revenue returns alone was about $17,000. This sum exceeds that paid by all other similar manufacturers united, and illustrates the preëminent popularity of this establishment.

On the first floor are situated the office, from which an electric telegraph communicates with their warehouse at 738 Broadway ; the packing room ; the engine room, supplied with a twenty-five-horse stationary, cut-off engine ; the veneer room ; blacksmith's shop ; the section for reception, sawing, and planing of lumber ; and that for drilling the slate beds. Here is in operation a horizontal drilling machine, the only one of the kind in existence, invented and made by the superintendent of the machinery in this factory. By this ingenious labor-saving machine, about fifty slate slabs can be drilled in a day, — four slabs being required for a bed, each bed containing fifty-six holes. In other factories this is done by slow and imperfect hand-work. The slabs are brought chiefly from the quarries in Vermont. In the veneer room there is generally on hand about $5,000 worth of stock, embracing the choicest

descriptions of wood, such as rose, walnut, birch, and mahogany; the other kinds of woods used in the tables being California laurel, maple, ash, oak, satin, etc. The value of the lumber used yearly is about $100,000. By means of two circular saws, on this floor, it is cut into broad rails, heads, stretchers, cushion-rails, and bed-frames, before being transferred to the second floor by a safety elevator, which reaches to every upper floor. As a preventive against fire, the boiler room, containing a thirty-horse-power boiler, is in an adjoining building. In the extensive yard of the factory, the lumber is seasoned for one and a half to two years before being manufactured.

On the second floor the lumber is received from the sawing room and piled up, and when completely seasoned it is planed by a large planing machine; after which it passes through various improved machines for tenoning, grooving, boring, and moulding. In another section is the setting-up room, where the various parts of the tables are completely fitted together, about eight at a time, the slabs and cushions being here carefully fitted to the frames.

On the third floor a section is devoted to the cushion room. Here are piles of variously shaped rubber, moulded and cut, and here they are added to the cushions by a process requiring great care and ingenuity. The cue, ball turning, and coloring rooms occupy other sections. Phelan's patent lathe, for turning billiard balls, is an ingenious machine, by which the balls, used by experts in their matches, are made perfectly uniform in size and weight. Here, about six thousand markers can be turned in a day, and fifty dozen cues can be made. Here, also, are various tenoning, mortising, and turning machines, a steam-box for stock, a newly invented scroll saw, etc., etc. On this floor there is at all times stuff for at least five hundred tables; and although considered sufficiently seasoned before it reaches this floor, it here remains until the larger seasoned lots are first manufactured. We here saw about 30,000 cues seasoning in piles. This apartment, like all the rest of the building, is heated by steam, and amply supplied with daylight and gaslight.

On the fourth floor is a section devoted to the finishing of all the parts of the cabinet work; the veneers are put on, the heads made, etc. Another section comprises the store room for finished stock of all parts of tables; and in another the cushions are covered with the fine green billiard cloth, the best in the world, made in France and Belgium.

The fifth floor has two sections; one is for polishing and fine varnishing the various parts — the best of piano copal varnish being used; the other, where the scraping, rubbing, and coarse varnishing are performed. All the markers and counters are here finished, about 100,000 being constantly on hand. Over two hundred sets of rails and legs (sixteen hundred of the former and twelve hundred of the latter) are usually found in this floor, on the east side of which is a balcony, which, with the roof, is used for drying purposes.

From two to three hundred tables, of all sizes, are constantly in process of construction at this factory, which is three times as large as any other in the world, and is capable of turning out four times as many as any other, owing to the large number of experienced mechanics employed, aided by improved machinery, by means of which a mechanical accuracy is insured equalled by no other establishment. It is the only one in the United States where all work pertaining to the business is performed, with the exception of the iron-work.

Nine different letters patent, for improvements in billiard tables and cushions, have been awarded Messrs. Phelan & Collender by the United States, and similar ones have been granted them by the French and English governments, showing their great devotion to their art. The superiority of their tables and combination cushions is now generally admitted by professional players and impartial judges. The combination cushion was invented and patented by Messrs. Phelan & Collender, and none of the many attempts to imitate it, we are assured, have proved anything but failures — a good evidence that it is as near perfection as possible.

The "parlor billiard and dining table" is one of the specialties of this house, originated by them; and by means of portable leaves and an easily operated crank, it is made to subserve the purposes of the two tables in one. Its price is about two hundred and fifty dollars; those of less size than five and a half by eleven feet being designed for the use of ladies and children. Like all the carom tables, it unites durability with elegance of design and finish.

About six months are required for the completion of a billiard table. The proprietors are gentlemen of long experience and celebrity in their line, and for years have sent their manufactures throughout the United States, Canada, West Indies, Mexico, Cen-

tral and South America, the Pacific coast, Europe, and to China and other parts of Asia.

They claim to have never made an inferior article, and their standard tables are to be found in nearly all first-class hotels in the country, as well as in the private residences of our opulent merchants and other citizens.

By strict attention to business, and their conscientious dealing with customers, this firm has conduced largely to the creation and recognition of a great industry in the United States.

Mr. Michael Phelan, the founder of the house, is one of those men of mark, strong, self-poised, and energetic, who have added so much lustre to the progress of manufactures in this country, and his career deserves a more extended notice than the limits of this article permit; but we have room for a partial sketch of the man and his successful career.

Michael Phelan, now (1871) in the fifty-fifth year of his age, is a native of Ireland. His father emigrated to this country in 1819, and established himself in the billiard business, he having as many as three or four rooms in different parts of the city of New York at the same time, and is still remembered by some of its older inhabitants. Succeeding well, and liking the country, in 1823 Mr. Phelan sent for his family; and the above year dates the advent of Michael Phelan to American citizenship. Although only seven years old at the time, he remembers his arrival perfectly. He also remembers the billiard table in one of his father's rooms, and how captivated he was when allowed to shove the balls around with the mace; and thus he has always dated his billiard experience from that time. Although he had stated terms in which he could practise, it was not until he had completed his fourteenth year that he was allowed to use the cue, and then, almost immediately, became a good player.

When he arrived at the proper age, his father bound him apprentice to learn the art of manufacturing jewelry, to which calling he served his full term, and became a good workman. On attaining his majority, the attractions to billiards became so strong that he finally determined to adopt the business for a livelihood. His father having previously deceased, Michael procured a situation as an attendant to a billiard room.

Being attentive, industrious, and obliging to all, he soon became an expert player, as well as a general favorite; thus he was early enabled to secure the means of going into business on his

own account. One of his first resolves was, that his rooms should be conducted on an entirely new basis; his establishment was for practising the game of billiards as an elegant amusement, and not as a vehicle for gambling operations; sharpers and loungers were ignored, and gentlemen patrons soon found that on retiring from a visit at Mr. Phelan's, their pockets were only minus the small amount paid for the game lost and refreshments used. This was certainly a new experience, and from the rapid increase of patronage Mr. Phelan soon found it was a popular and a profitable one.

In 1850 Mr. Phelan had come to be looked upon as the most expert and scientific player in the country; and in the same year he prepared a work entitled "Billiards Without a Master," which enjoyed a large sale.

The many imperfections in billiard tables, as then produced, had long occupied the attention of Mr. Phelan; his quick perception of the requisites of the game made the deficiencies most glaring; and his invariable plan of using his full energies for the improvement of all phases of the game, was of course applied to this important particular. At first he endeavored to get manufacturers to work up and practically test his then possibly crude ideas of improvement; but although the table-makers were ever using their utmost exertions to get favorable opinions from Mr. Phelan touching their productions, yet he found it impossible to get one of them to test the radical changes he proposed in the principal machinery of the science. Even at a later period, when a then well-known maker was urged by a mutual friend of the parties to make and test a table on the plan proposed by Mr. Phelan, the sagacious manufacturer remarked, "No, sir; I have no desire for those claimed-to-be improvements; I admit that Mr. Phelan is a first-class billiard player, and thoroughly understands that portion of the business; and I think I understand my portion of it quite as well; therefore I wish him to attend to his business, and I will take care of mine."

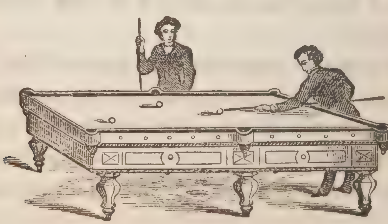
The uncouth remark came to the ears of Mr. Phelan, but did not dispirit him. He was determined to produce an American billiard table that would become the standard model for the whole world; and pecuniary reasons were the only ones which prevented him from then commencing the manufacture on his personal account.

Mr. Phelan visited Europe in the fall of 1851, and on his return,

in 1852, entered, with renewed love, upon his business. The darling idea of starting his model billiard-table factory was yet uppermost in his mind. The California gold excitement was then at its zenith. Mr. Phelan took the fever; he naturally concluded that here was a capital opportunity to secure a sufficient sum to start his intended permanent career. But it required some time to prepare for so long a journey, and arrange for the care of his family during his absence. He went away, however, in the fall of the year 1854, and duly arrived in San Francisco. Here he was prosperous from the start, his elegant billiard hall immediately becoming one of the chief points of interest of the Golden City. Early as this was in the history of the great metropolis of the Pacific, yet for the time it had flourished it will be remembered that its population had become unprecedentedly extensive, and composed of persons of all classes and nations. Every variety of interests was most profusely represented, and probably none more ably than the science of billiards. Mr. Phelan's great reputation had, of course, preceded him; and while all the experts were determined on separate bouts with him, in rapid succession each was vanquished, and, as in New York, he was again pronounced unconquerable.

Mr. Phelan's financial success in California was commensurate with his professional skill, and he returned to New York prepared to enter upon his career as a manufacturer, which he has since pursued individually, and in company with his able and accomplished partner, Mr. Collender, with what success we have already noted.

Mr. Phelan is the author (1858) of a comprehensive and ably written work, entitled "The Game of Billiards," which secures to him a place among the literary men, as well as chief business men of the day.



BELLS, HISTORY AND MANUFACTURE.

PARTIAL HISTORY. — ETYMOLOGY. — CONSECRATION OF BELLS. — THE "PASSING" BELL. — THE "CURFEW" BELL. — FEAST OF OSIRIS. — THE CODONOPHORUS: HIS DUTIES. — SCHILLER'S "BELLS." — POE AND OTHER POETS. — ELECTRICAL BELLS. — MUSICAL BELLS. — LARGE BELLS. — GREAT BELL OF MOSCOW. — MANUFACTURE OF BELLS. — INSCRIPTIONS ON BELLS, ETC.

In civilization the bell has played an important part, and its history is among the most interesting of narratives, whether it be of its rude early state, or of that period when science added to its vibrations the tones and harmonics of music. While the founding of bells is not so complicated a process as the manufacture of watches or steam-engines, yet it requires the exercise of the nicest discrimination; for the delicacy, exactness, and perfect sense of adjustment of that sensitive organ, the ear, is to be gratified or displeased by the bell to be made; and in its power to produce agreeable sounds lies all its utility. The first manufacture of bells was necessarily very imperfect, — little better than common kettles, — since nothing was then known of that nice combination of sounds with reference to the effect of each and all upon the sound produced, or of the shaping of the instrument to modify the vibrations, or of the elevation and kind of tower in which to hang it — all affecting sound. To the genius of a later day was it left to develop these scientific facts, and fix their relation to the efficiency of the bell.

History gives us no definite account of the origin of bells. Small, tinkling instruments are mentioned by the old Hebrew writers as having been used as appendages to the dress worn by high priests and persons of distinction; but of their shape nothing is recorded. The origin of the name "bell" is the antique Saxon word *bellan*, to bawl or bellow. The Hebrew word translated by our word "bell" is susceptible of other translations. The bell is used to this day in Catholic countries for a similar purpose to that recorded in Scripture. Perhaps no instrument of music (for it is

ranked by musicians among the musical instruments of percussion) is more intimately associated with the religious and imaginative, as well as with the most joyous and most sad feelings of the human heart. A quaint old writer has described the bell's threefold duties thus : —

"To call the fold to church in time,
We chime.
When joy and mirth are on the wing,
We ring.
When we lament a departed soul,
We toll."

Small bells were used in the early ages for civil, military, and religious purposes, and bells of a larger size are in our day extensively used for similar purposes.

The first use of bells in Christian churches to call people to service, of which we have records, was by St. Paulinus, in Campania, about the year 395 of our era. By the Roman church, bells are solemnly blessed and consecrated for the work of summoning worshippers to their religious rites. The consecration of bells dates back to a very early period. In Charlemagne's capitulary of 787 we find the injunction, "*ut cloccæ baptizentur*" (let bells be baptized); and in the old liturgies of the Catholic church is a form of consecration directing the priests to wash the bell with water, anoint it with oil, and mark it with the sign of the cross, in the name of the Trinity. The practice of naming bells is also an early one. The Vesper bell, which has been immortalized by poets, is the call to evening prayer. The "passing bell" was rung, among the ancient customs, in order to remind the hearers to pray for the soul that was leaving the world. From this old custom is probably derived that of tolling bells at funerals, as practised to-day.

Some historians tell us that William the Conqueror introduced into England from France the custom of ringing the Curfew bell, which "tolled the knell of parting day." Others say that King Alfred introduced the custom. It consisted of ringing a bell at eight or nine o'clock in the evening, when every one was commanded to extinguish lights and cover up the fires in the house. ("Curfew" is derived from the French words *couvre feu* — cover fire.) The practice of ringing a bell at certain hours was not peculiar to England, but obtained to considerable extent on the Continent. Most buildings being then of wood, it was intended as a precaution against fires, which were common. The passing

and curfew bell are still represented in some American villages, especially in New England.

As a signal to call people together in any concerted action, the bell has been used from remote times. The feast of Osiris, among the Egyptians, was announced by the ringing of bells; and the same sound to this day notifies hungry mortals of the time to satisfy their appetites. The Romans announced the time of bathing by the ringing of bells; and the early Christians made use of the method to designate the hour of prayer. In Britain, bells were applied to church purposes before the end of the seventh century. In England, as formerly at Rome, bells were frequently made of brass. In times of public danger the bells were rung to alarm the country. Among the Greeks, those who went the nightly rounds in camps or garrisons, carried with them little bells, which they rung at each sentry-box, to see that the soldiers on watch were awake. A codonophorus, or bellman, also walked in funeral processions, a little in advance of the corpse, not only to keep off the crowd, but to advertise the *flamen dialis* to keep out of the way, lest he should be polluted by the sight, or by the funerary music. The priest of Proserpine at Athens rung the bell to call the people to sacrifice. There were also bells in the houses of the great, to call the servants in the morning. Bells were put upon the necks of criminals going to execution, to warn persons to avoid so ill an omen as the sight of the hangman or the condemned man. We find in history the mention of bells on the necks of brutes, and taking them away was construed as theft by the civil law. The custom in this country of putting bells on cows and sheep, in order the better to find them if they stray away, doubtless grew out of this practice of the ancients. The various early uses of the bell have been summed up in the following old Latin distich: —

> "Laudo Deum verum, plebem voco, congrego clerum,
> Defunctos ploro, pestem fugo, festa decoro."

(I praise the true God, call the people and convene the clergy, mourn the dead, drive away the pestilence, and grace the feast.)

Schiller has given us a "Song of the Bell," the motto of which is more terse: —

> "Vivos voco, mortuos plango, fulgura frango."

In his poem all the joys, sorrows, pangs, emotions, terrors, and blessings, attendant on humanity, in connection with the part

which the bell plays, are most vividly portrayed. The poem is so touchingly beautiful that we reproduce a portion of it here.

"What we are forming in the mould
By dint of hand and melting flame,
High in the church tower shall be tolled,
And far and wide our work proclaim.

"To distant days it shall remain;
Its notes on many an ear shall fall;
Its chimes with sorrow shall complain,
And ring abroad devotion's call.

"Whatever to us mortals here
A shifting destiny e'er brings,
Is struck upon its metal clear,
Which to all ears the lesson rings.
Clear and full with festal sound,
It hails the lovely infant child
First entering on his earthly round,
Borne in the arms of slumber mild.

"When the manly and the fair,
When strength and beauty form a pair,
Then rings it out a merry song;
Lovely in the young bride's hair
Shines the bridal coronal;
While the church-bell-chimes so fair
Summon to the festival,
From the dome,
Heavy and long
Sounds the bell —
A funeral song;
Solemnly with measured strokes, attending
Weary wanderer on his last way wending."

None the less beautiful, though of a different vein of sentiment, is the poem of Edgar A. Poe, so familiar to nearly all readers. Whittier has also immortalized, in rich verse, the ringing of bells, to arouse the feelings of patriotism in the breast, on the passage of the constitutional amendment abolishing slavery.

"It is done!
Clang of bell and roar of gun
Send the tidings up and down.
How the belfries rock and reel,
How the great guns, peal on peal,
Fling joy from town to town!"

Longfellow, in one of his most delicious poems, has sounded the praises of the Christmas bells. And England's poet laureate,

Tennyson, has given to the bells some of his choicest imagery, on the death of the year.

> "Ring out, wild bells, to the wild sky,
> The flying clouds, the frosty light:
> The year is dying in the night;
> Ring out, wild bells, and let him die," etc.

Electrical Bells.

Electrical bells are used in a variety of entertaining exhibitions by electricians. The apparatus consists of three small bells, suspended from a narrow plate of metal, the two outermost by chains, and that in the middle, from which a chain passes to the floor, by a silken string. Two small knobs of brass are also suspended by silken strings, one on each side of the bell in the middle, which serve for clappers. Connected with an electrical conductor, the outermost bells suspended by the chains are charged, attract the clappers, and are struck by them. The clappers are repelled by these bells, and attracted by the middle bell, and discharge themselves upon it by means of the chain extending to the floor. After this they are again attracted by the outermost bells, and thus, by striking the bells alternately, occasion a ringing, which may be continued at pleasure.

Musical Bells.

Music bells are still in use in some parts of Europe, and to some extent in this country, and are regarded as delightful. They are played upon by means of keys, not unlike those of a piano-forte. An old painting of King David represents him as playing, with a hammer in each hand, upon five bells, which were hung up before him. The music of the *thirty-three* bells which were suspended in the tower of the cathedral of Antwerp is highly celebrated. One of these bells was seven feet in width and eight feet high. The Swiss bell-ringers, famous for their performances, produce the most exquisite melody from hand-bells. The Peak family, and others, in this country, have also become famous for their bell-music. So skilful are they in the use of bells, that they will change from one to another with the greatest rapidity. The bells vary in size, from a large cow-bell to the smallest dinner-bell, each with a key differing from that of the rest, and as many as *forty-two* are used by a company of seven persons.

Large Bells.

Bells were introduced into use in churches about the year 395 of the Christian era. Since then many very large, and on this account prominent, bells have been made. As early as the sixth century churches were furnished with the campanile, or bell-tower, which still continues to be one of their distinguishing features. Several bells were used in a single church, as is still the custom when arranged in chimes, or, as is sometimes the case, without regard to harmony of tones. This practice of ringing bells in change, or regular peals, is said to be peculiar to England, and the custom seems to have been introduced in the times of the Saxons.

There are many very large bells in use. The church of the Abbey of Croyland, in England, had one great bell, named *Süthlac*, presented by the Abbot Turketulus, who died about the year 870; and subsequently, six others, presented by his successor, Egelric, and named Bartholomew and Betelin, Turketel and Tatwin, Bega and Pega. But Russia exceeds all other countries in its founderies for bells. In Moscow alone, before the revolution, there were no less than seventeen hundred and sixty-six large bells. In a single tower there were thirty-seven, one being so large that it took twenty-four men to ring it, and this was done by pulling the clapper. Its weight is estimated at two hundred and eighty-eight thousand pounds. The great bell, cast by order of the Empress Anne, in 1653, and now lying broken on the ground, is believed to weigh four hundred and forty-three thousand seven hundred and seventy-two pounds. It is nineteen feet high, and measures around its margin sixty-three feet and eleven inches. The value of the metal alone in this bell is estimated at over three hundred thousand dollars. Whether this bell was ever hung, or not, authorities seem to differ. Clarke, in his Travels, says of the bells in Moscow, and of the great bell in particular, "The numberless bells of Moscow continue to ring during the whole of Easter week, tinkling and tolling without harmony or order. The large bell near the cathedral is only used upon important occasions, and yields the finest and most solemn tone I ever heard. When it sounds, a deep hollow murmur vibrates all over Moscow, like the fullest tones of a vast organ, or the rolling of distant thunder. This bell is suspended in a tower called the belfry of St. Ivan, beneath others, which, though of less size, are enormous.

It is forty feet and nine inches in circumference, sixteen and a half inches thick, and weighs more than fifty-seven tons." The great bell of Moscow, the largest ever founded, is in a deep pit in the midst of the Kremlin. The story of its fall is a fable, but continues to be propagated. The fact is, the bell remains where it was originally cast; it was never suspended. A fire took place in the Kremlin, the flames of which caught the building erected over the pit in which the bell yet remained. The metal became hot, and water thrown to extinguish the fire, fell on the bell, causing the fracture it wears. This bell is, indeed, a mountain of metal. It is said to contain a large proportion of gold and silver, for, while it was in fusion, the nobles and the people cast in as votive offerings their plate and money. But this story is probably fictitious. The natives of Russia regard the bell with superstitious veneration, and they will not allow even a grain to be filed off that it may be tested; at the same time we are informed that the compound has a white, shining appearance, unlike bell metal in general; and perhaps its silvery appearance has strengthened, if not given rise to, the conjecture respecting the richness of its materials. On festival days the peasants visit the bell as they would a church, and cross themselves as they descend and ascend the steps leading to the bell. In 1837, the Czar Nicholas caused the great bell to be elevated from the pit in which it lay, and placed upon a granite pedestal. Upon its side is seen, over a border of flowers, the figure of the Empress Anne, in flowing robes. The bell has been consecrated as a chapel; the door is in the aperture made by the piece which fell out. The room is twenty-two feet in diameter, and twenty-one feet three inches in height.

The bells of China rank next in size to those of Russia. In Pekin, says Father Le Compte, there are seven bells, each weighing one hundred and twenty thousand pounds. Excepting the bells recently cast for the new houses of Parliament, the largest of which weighs fourteen tons, there is no bell in England larger than that cast for York Minster, in 1845, which weighs twenty-seven thousand pounds. This is only seven feet and seven inches in diameter. The "Great Tom" of Oxford weighs seventeen thousand pounds, and the Great Tom of Lincoln twelve thousand pounds. The bell of St. Paul's, London, is nine feet in diameter, and weighs eleven thousand five hundred pounds. One placed in the cathedral of Paris, in 1680, weighs thirty-eight thousand pounds. Another in Vienna, cast in 1711, weighs forty thousand

pounds. The famous bell called Jusanne of Erfurt, is considered to be of the finest bell metal, containing the largest proportion of silver; its weight is about thirty thousand pounds. It was cast in 1497. In Montreal, Canada, is a bell larger than any in England, in a tower of the cathedral of Notre Dame. Its weight is twenty-nine thousand four hundred fifty-eight pounds. In the opposite tower is a chime of ten bells, the heaviest of which weighs six thousand forty-three pounds; and their aggregate weight is twenty-one thousand eight hundred pounds.

Chimes are a collection of bells struck with hammers; or a set of music bells struck by hammers acted on by a pinned cylinder, or barrel, which is made to revolve by clock-work. These are frequently attached to time-pieces, and are so arranged as to produce chimes, or tunes, at stated intervals.

There are but few bells of very large size in the United States. The heaviest is the alarm bell on the City Hall in New York. It was cast in Boston, and weighs about twenty-three thousand pounds. Its diameter, at its mouth, is about eight feet; its height about six feet, and its thickness at the point where the clapper strikes, from six and a half to seven inches. The bell now in Independence Hall, Philadelphia, is celebrated as being connected with the Fourth of July, 1776, when it first announced by its peals the declaration then made, the most important event in the history of our country. It was imported from England in 1758, and, owing to its being cracked on trial by a stroke of the clapper, was recast in Philadelphia, under the direction of Mr. Isaac Morris, by whom was probably chosen the following inscription, which surrounds the bell near the top, from Leviticus xxv. 10: "Proclaim liberty throughout the land, unto all the inhabitants thereof." Immediately beneath this is added, "By order of the Assembly of the Province of Penn. for the State House in Phil." Under this again is, "Pass & Stow, Phil. MDCCLIII." In 1777, during the occupation of Philadelphia by the British, the bell was removed to Lancaster. After its return, it was used as the State House bell, until the erection of the present steeple, with its bell, in 1828. Then it ceased to be used, excepting on extraordinary occasions. Finally it was removed to its present resting-place in Independence Hall. Its last ringing, when it was unfortunately cracked, was in honor of a visit to Philadelphia of Henry Clay. There are no other bells of special interest in this country.

Metals used.

Bells have been made of different metals. In France, formerly, iron was used, and in other parts of Europe brass was a common material. In Sheffield, England, the manufacture of cast-steel bells has recently been introduced. This material is said to have an advantage over others in being of greater strength and less weight. But the tone of steel bells is said to be harsh ; hence such bells will probably never be extensively used. But the bell metal which is most generally approved is an alloy of copper and tin, in proportions varying from sixty-five to eighty per cent. of copper, and the remainder tin. But other metals are often introduced, as zinc, with the object of adding shrillness to the sound, silver, to its softness, and also lead. Cymbals and gongs contain eighty-one parts copper and thirteen tin. Manufacturers in this country think that the value of silver in bell-metal is purely imaginary, and condemn the use of anything but copper and tin. Three and a half parts copper to one of tin make, perhaps, the best proportion. The founders have a diapason, or scale, by which they measure the size, thickness, weight, and tone of their bells.

The sound of a bell is produced by the vibratory motion of its parts, somewhat like that of a musical chord. The stroke of the clapper must necessarily change the figure of the bell, and from a circle convert it into an ellipse ; but the metal having a great degree of elasticity, that part beaten by the clapper and driven farthest from the centre, will return, and even incline nearer the centre than before ; and thus the external surface of a bell undergoes alternating changes of figure, and by this means gives that tremulous motion to the air, in which the sound consists. The proportion of metals, and shape and proportion of bells, all affect the sound ; hence the adjusting of a bell to produce a smooth, uniform, even sound, requires skill, and experience, and thorough testing.

There are different theories as to the philosophy of sound produced by the bell. One eminent writer maintains that a bell is a compound of an infinite number of rings, which, according to their dimensions, have different tones, as chords of different lengths have ; and when struck, the vibrations of the parts immediately infringed determine the tone, being supported by a sufficient number of consonant tones in the other parts.

Bells are heard to greater distance when placed on plains than

on hills, and still farther in valleys than on plains; the reason of which seems to be, that the higher the sonorous body, the rarer is the medium, and consequently the less the impulse it receives, and the less proper medium is it to convey sound to a distance.

Manufacture of Bells.

The European process of casting bells is, to make the mould in a depression in the sand floor of the foundery, piling up a hollow case of brickwork upon a solid foundation, in which a fire is kept burning to keep the liquid metal, when poured around it, from cooling too rapidly. The outer surface of the case is the shape of the inner surface of the bell. To form the outer surface, a cover of earthenware is fashioned to fit over the case, and leaves between that and itself a vacant space, to be filled with the metal. This arrangement is deficient in not providing proper escape for the gases which are engendered in heavy castings in the earth, and which are likely to make the metal porous, or, being highly inflammable, to explode with great damage. But an inproved process has been introduced in this country, consisting of the use of perforated iron cases, the outer one in the shape of the bell, and the inner one of the case, which sets in the centre of its saucer-shaped foundations. Each of these receives a coating of loam, the outer one within, and the inner upon its outer surface; but over the latter is first wrapped a straw rope, which, taking fire and burning slowly, as the metal is poured between the two cases, leaves a free space for the bell to contract in while cooling, without straining. The perforations through the cases let out the vapors, and also serve to keep the coating of loam in place. As the gas escapes through these holes, it burns with a pale blue flame, without risk.

The best proportion of the height of a bell to its greatest diameter is said to be as twelve to fifteen. In conformity to the laws of acoustics, the number of vibrations of a bell varies in inverse ratio with its diameter, or the cube root of its weight.

Inscriptions on Bells.

Many of the inscriptions found on old bells are quaint and interesting, as indicating the superstitions and fancies of the ancients in connection with bells, as well as their great reverence

for them and fear of their power. They also indicate, in many cases, the customs of the people. These inscriptions were often in honor of some saint, or to commemorate some act of special mercy or charity, or deliverance. A peal of eight bells in the tower of St. Helen's church, Worcester, England, cast in the year 1706, bears inscriptions in couplets commemorative of Blenheim, Barcelona, Ramillies, Menia, Turin, Egen, Marlborough, and Queen Anne.

The following inscription has been common in England for three hundred years, and also much used in this country: —

> "I to the church the living call,
> And to the grave do summon all."

Selections of some Old Inscriptions.

One upon a bell in Wiltshire, England, cast 1619: —

> "Be strong in faythe, prayes God well
> Francis Countess Hertford's bell."

Upon one in Oxfordshire, cast 1667: —

> "I ring to sermon with a lusty boome
> That all may come, and none stay at home."

Upon one in Nottinghamshire, cast 1603: —

> "Jesus be our spede."

Upon one in Wiltshire, cast 1585: —

> "O man, be meeke, and live in rest."

Upon one (a fire bell) in Dorsetshire, cast 1652: —

> "Lord, quench this furious flame;
> Arise, run, help, put out the same."

Upon one in Somersetshire, cast 1700: —

> "All you of Bath that hear me sound,
> Thank Lady Hopton's hundred pound."

Upon one in Hampshire, cast 1600: —

> "God be our guyd."

Upon one in Cambridgeshire (St. Benet's, Cambridge), one of a peal of six, cast 1607 : —

> "Of. al. the. bells. in. Benet. I. am. the. best.
> And. yet. for. my. casting. the. parish. paide. lest."

Upon one in Warwickshire, cast 1675 : —

> "I ring at six to let men know
> When too and from thair worke to go."

Upon one in Staffordshire, cast 1604 : —

> "Bee it known to all that doth me see
> That Newcombe of Leicester made me."

John Martin also makes himself known upon one (of a peal of three) in Worcestershire, cast 1675 : —

> "John Martin of Worcester he made wee
> Be it known to all that do wee see."

The great bell of Rouen, in France, presented to St. Mary's church by George, Archbishop of Rouen, bore this inscription : —

> "Je suis nommèe George d'Ambois,
> Que plus que trente six mil pois;
> Et si qui bien me poysera
> Quarante mil y trouvera."

(I am named George of Amboise, and [am of] more than thirty-six thousand pounds' weight; and, if any one would weigh me well, he'd find [me] forty thousand pounds in weight.)

One of three in Orkney, Scotland, cast in 1528, bears the following : —

> "Maid be master robert maxwel, Bishop of Orknay y^e^ second zier of his consecration y^e^ zier of Gode I^m^ V^e^ XXVIII., y^e^ XV. zier of Kyng James y^e^ V. be robert borthvyk; maid al thre in y^e^ castle of Edinburgh."

Most intimately is the voice of the bell associated with the religious and imaginative, as also with the most joyous and the saddest feelings of mankind.

Cornell University Chimes.

One of the finest chimes in the United States is at Cornell University, at Ithaca, New York. There are ten bells, the largest weighing four thousand eight hundred and eighty-nine pounds,

and the smallest two hundred and thirty, with a total weight of metal of nearly eleven thousand five hundred pounds. They represent, in the order of their weight, beginning with the great bell, the following musical notes: D, G, A, B, C, D, E, F, F sharp, and G. The largest of the chimes bears the following inscriptions: "The Gift of Mary, Wife of Andrew D. White, First President of Cornell University, 1869;" "Glory to God in the highest, and on earth peace, good will toward men;" "To tell of Thy loving-kindness early in the morning, and of Thy truth in the night season;" together with the following stanza, written expressly for it by James Russell Lowell: —

I call as fly the irrevocable hours,
  Futile as air or strong as fate, to make
Your lives of sand or granite: awful powers,
  Even as men choose, they either give or take.

The nine smaller bells all bear couplets from Tennyson's "In Memoriam," commencing with the smallest, as follows: —

FIRST BELL.

Ring out the old — ring in the new;
Ring out the false — ring in the true.

SECOND BELL.

Ring out the grief that saps the mind;
Ring in redress to all mankind.

THIRD BELL.

Ring out a slowly dying cause,
  And ancient forms of party strife.

FOURTH BELL.

  Ring in the nobler modes of life,
With sweeter manners, purer laws.

FIFTH BELL.

Ring out false pride in place and blood;
Ring in the common love of good.

SIXTH BELL.

Ring out the slander and the spite;
Ring in the love of truth and right.

SEVENTH BELL.

Ring out the narrowing lust of gold;
Ring out the thousand wars of old.

EIGHTH BELL.

Ring out old shapes of foul disease;
Ring in the thousand years of peace.

NINTH BELL.

Ring in the valiant man and free,
  The larger heart, the kindlier hand;
  Ring out the darkness of the land;
Ring in the Christ that is to be.

The ninth bell also bears the following: "This Chime, the gift of Miss Jennie McGraw to the Cornell University, 1868." The mechanical apparatus attached to the bells is simple, ingenious, and effective. One of the students of the University is always "Master of the Chimes," and during the day and evening, at different hours, the bells "discourse sweet music."

WIRE-DRAWING.

OLDEST KNOWN METHODS OF MAKING WIRE. — CUTTING AND HAMMERING. — HAND-DRAWN WIRE. — WIRE-DRAWING MACHINERY. — PROGRESS OF THE INDUSTRY IN EUROPE. — INTRODUCTION IN AMERICA. — UNIVERSAL USE. — FROM SUSPENSION BRIDGES TO GOLD LACE. — PROCESS OF DRAWING. — ROLLING THE RODS. — THE DRAW-PLATE. — HOW THE FINEST FRENCH PLATES ARE MADE. — THE DRAW-BENCH. — SIMPLICITY OF THE PROCESS. — DUCTILITY OF DIFFERENT METALS. — RAPIDITY OF DRAWING. — GAUGES. — PLATES FOR VARIOUS SHAPES. — PERFORATED RUBIES. — WONDERFUL DUCTILITY OF SILVER AND PLATINUM. — WIRES OF ASTONISHING LENGTH AND LIGHTNESS. — SPIDER LINES FOR TELESCOPES. — PROPORTIONATE INCREASE OF LENGTHS AND DIMINUTION OF DIAMETERS IN DRAWING.

THE manufacture of wire, particularly from gold and silver, is of very great antiquity, and the earliest method, according to the Book of Exodus (chapter xxxix.), was "to beat the gold into thin plates, and cut it into wires." The next step pursued by "wire-smiths," for centuries, was to make wire from ductile metals by hammering. "Wire-drawers," who drew wire by hand, in Germany and elsewhere in Europe, flourished in the fourteenth century, and soon afterwards wire was drawn by machinery, propelled by water power. At first these machines were used almost exclusively for drawing gold and silver wire; but in the fifteenth century England was both manufacturing and importing iron and brass wire, and Germany was making the finest wire for hooks and eyes, cards, etc. In the seventeenth century England added copper wire to the list, and wire-drawing became an important industry in that country. The business began early in the present century in the United States, and there are now extensive wire-drawing establishments in New York, Providence, Worcester, Boston, and other cities.

There is scarcely a branch of metal manufacture of more universal application. Wire is twisted by machinery into the powerful cables which suspend bridges; it furnishes cables for submarine

telegraphs, and ropes for ships, mines, and other purposes; it supplies the thousands of miles of telegraph lines; it is woven by machinery strong enough to make wire fences, and sufficiently delicate to manufacture fine wire cloth; steel wire is drawn for all kinds of needles; woven wire of iron, brass, and copper appears in flour, paper, and other machinery; sieves, screens, fenders, cages, baskets, dish-covers, nets, and an infinity of other forms; it is drawn down to furnish the fine, hair-like wire for astronomical and mathematical instruments; gold and silver wire is plated or woven into exquisite filigree work, into chains, and into thread for making gold lace. In making wire for gold lace, or for the finest filigree work, the wonderful ductility of gold and silver is exhibited; for silver, merely coated with gold leaf, may be drawn down to the smallest size, and still show a perfect coating of gold. For gold lace, wires so drawn are flattened between steel rollers to show a larger surface; and much of the "gold" filigree work displayed in jewelry is really silver with a gold overcoat. Thus everywhere, in thousands of articles of use and luxury, the employment of wire is indispensable.

The process of wire-drawing is as follows: The wire rods, of one-fourth, three-eighths, or one-half inch in thickness, come from the rolling mill in coils or bundles, and are heated and re-rolled in grooved rollers, one above the other, so that the rod can run from the first to the second, and then to the third roll, without reheating. These rollers run with great rapidity, and the final groove in the third roller reduces the rod to a coarse wire, say one-eighth of an inch, ready for the first hole in the draw-plate. The draw-plate is a flat piece of hard steel, punctured with holes corresponding to the various sizes or "numbers," to which wire for different purposes is drawn. The French draw-plates, which are considered the best, are made with the greatest care in tempering and hammering of a combined plate of wrought iron and steel, the steel face being on the side from which the wire comes through. The holes punched in the plate are tapering, with the smallest orifice on the steel side; the reduction of size in the series is very gradual, and when the holes are worn by use, the plate can be heated, hammered, tempered, and re-punched. The wire, whether iron, brass, or copper, is annealed and drawn cold. The machinery, which is simple, consists of a draw-bench, which takes the wire from a reel to the first hole in the draw-plate, through which it passes to another reel or drum, on which it is wound ready to go

through the second orifice; and so on down the series to the required size. As the wire is drawn down, it becomes less ductile and more brittle, and must be annealed and cooled before it is further drawn. Grease, and for the finer sizes, wax is used for lubricating during the process. There is a process also for covering brass wire with a thin film of copper, which greatly facilitates the process of drawing, while the copper can wholly be removed in the last annealing. In annealing steel wire during the drawing, its carbon is retained by covering it with charcoal dust in the annealing oven.

The rapidity of drawing depends upon the ductility of the metal and the size of the wire. Of the wire in common use, copper is the most ductile, then steel, next iron, brass, and zinc. Gold, platinum, and silver are far more ductile, and are capable of being drawn to greater length and fineness. The speed may be increased as the wire is attenuated; iron and brass, according to size, are drawn twelve inches per second to forty-five inches per second, and the finer numbers of silver and copper may be drawn at the rate of sixty or seventy inches per second.

It will be seen that the process of drawing wire is quite simple, and gauges have been adopted which uniformly measure all the sizes, or numbers, of merchantable wire wherever made. The draw-plates can be punched so as to draw oval or other shaped wires, and the ridged "pinion wire" used in timepieces. For drawing very fine wire, where the extremest uniformity is requisite for any length, plates are prepared with perforated rubies or other hard stones, and through one of these silver wire has been run one hundred and seventy miles in length, in which the most delicate test could detect no difference in diameter in any part. Gold and platinum have been drawn to the "spider line" for the field of a telescope, by coating the metal with silver, drawing it down to the finest number, and then removing the coating by acid, leaving the almost imperceptible, but perfect, interior wire, which, in the case of platinum, — in an experiment made by Dr. Wollaston, of London, — is said to have been so attenuated that a mile's length weighed only a grain. In drawing ordinary wire, as the diameter diminishes one-half, one-third, one-fourth, etc., the length increases four, nine, sixteen, etc., times.

STARCH.

SOURCES FOR THE PRODUCTION OF STARCH. — STARCH IN QUEEN ELIZABETH'S DAY. — BEAU BRUMMELL'S CRAVATS. — DEMAND FOR STARCH. — COTTON-PRINTING ESTABLISHMENTS. — LAUNDRIES. — EDIBLE STARCH. — PATENT FOR POTATO STARCH. — PROPORTION IN VARIOUS GRAINS. — WHITE FLINT CORN. — PROCESS OF MANUFACTURE. — THE GREAT MANUFACTORIES OF THE UNITED STATES. — HOW STARCH IS MADE FROM CORN. — THE AMOUNT PRODUCED. — USES FOR THE GLUTEN. — LUMBER FOR PACKING-BOXES.

Starch plays an important part in the economy of Nature. It is found in greater or less quantity in all the cereals — very pure in rice, barley, and Indian corn, and associated with gluten, mucilage, and saccharine matter in wheat, potatoes, peas, beans, oats, etc. It can be extracted from horse-chestnuts; and every farmer's wife knows how to make starch, if necessary, from wheat flour and potatoes, by simply kneading them through a sieve with cold water, the settlings of the milky fluid which flows through the strainer being starch.

Yet this article, so necessary to cotton manufactories, laundries, and to every household, that the daily consumption in the United States alone is estimated at two hundred and fifty tons, was scarcely known till the Elizabethan era, when a very inferior quality was used to starch the ruffs then worn. Beau Brummell was famous in London for his stiffened cravats, and long kept the secret of starch, as applied to that article of wear. But what was then an article of luxury and fashion for a fastidious exquisite is now everywhere an indispensable necessity.

During the last century starch was used in England in printing cotton with colors, in stiffening linen, and in making hair powder; and soon after the beginning of the present century it became an important branch of manufacture in that country. The cotton mills at Manchester and elsewhere demanded enormous quantities, single establishments using more than three hundred tons in a year. The grains and vegetables commonly used in England and

on the continent for the manufacture of starch are wheat, barley, rice, and potatoes, and in France, in addition to these, horse-chestnuts. Abroad, as in this country, large amounts of edible starch are made, as well as starch for manufacturing and laundry purposes.

In 1802 John Biddis, of Pennsylvania, secured in this country a patent for making potato-starch, and manufactories of this kind are in operation in several states, particularly at or near places where cotton goods are printed. Potatoes yield eight pounds of pure starch to the bushel, and the potato-starch manufactories, which are generally much smaller than those engaged in corn-starch manufacture, will use from fifteen thousand to thirty thousand bushels of potatoes in a year.

The proportion of starch in grains is nearly as follows: In buckwheat, forty-four to fifty-two per cent.; barley, sixty to sixty-eight; rye, sixty to sixty-five; wheat, thirty-five to seventy-seven; Indian corn, sixty-five to eighty, which is next to rice, which contains from seventy-five to eighty-seven per cent. It will thus be seen that in the United States, the natural home of maize, Indian corn is the most desirable for starch manufacture, and large quantities of the white flint variety are raised expressly for the purpose.

In making starch from wheat the flour is kneaded with water, and washed through a fine wire sieve, after which the fluid, with the addition of a little yeast, is fermented. This process separates the gluten from the starch, and the gluten may be used with fresh flour to make macaroni and vermicelli, or may be mixed with potatoes into a wholesome bread. Another process, first applied to starch-making from rice, but equally applicable to other grains, is to mash the rice in a weak alkaline solution, and then add a gallon of water and two hundred grains of potash to every two pounds of rice. In twenty-four hours the liquid is drawn off, the rice is washed, drained, and ground, fresh lye is added, and the mixture is allowed to stand, with frequent stirrings, twenty-four hours longer. In the course of seventy hours afterwards the gluten rises, and is taken off, leaving the starch and fibrous part of the grain. This deposit is washed with cold water, and is then left for the fibrous portion to settle, when the clear starch is drawn off and dried.

Of the corn-starch manufactories, there are two very large ones in the United States, one at Oswego, N. Y., and the other at Glen Cove, L. I. They use the best kinds of white flint corn, brought

to the works and ground on the premises. It is conveyed to the mills through troughs filled with water, and the mixed meal and water go through other troughs to the tubs, where the separation of the starch is effected. The starch fluid then goes to large vats for the partial removal of the water, then into smaller tubs for further draining ; the starch is next placed in mass on brick shelves, where absorption and evaporation further dry it ; and kiln-drying and packing complete the process. The vats for purifying hold millions of gallons, and powerful steam engines drive the mills and machinery.

The white flint corn will give about twenty-three pounds of starch to the bushel. The gluten is saved for feeding to hogs, horses, and cattle. The careful process of manufacture in the large establishments, and especial watchfulness in the fermenting, result in the production of a clear, white and strong starch, entirely free from sourness. These establishments each produce from twenty to thirty tons of starch per day. There are numerous smaller establishments throughout the country, which manufacture starch for various dessert and invalid preparations, as well as for laundries, and the "farina" and "maizena" business is also carried on in the great manufactories. It is believed that the manufactories at Oswego and Glen Cove each produce more starch in a year than any similar establishments in Europe, and both consume annually millions of feet of lumber, generally basswood, for making the boxes in which the starch is packed.

ARTIFICIAL LIMBS.

THE TENDENCY OF CIVILIZATION. — MAN'S PHYSICAL AND MORAL POSITION IN NATURE.— THE CURE OF WOUNDS AMONG SAVAGES. — SURGERY AMONG THE EGYPTIANS. — THE TESTIMONY OF HERODOTUS. — SURGERY AMONG THE GREEKS. — AMONG THE ROMANS. — THE USE OF DISSECTION IN THE STUDY OF ANATOMY. — SURGERY AMONG THE EARLY CHRISTIANS. — THE REVIVAL OF SURGERY. — SURGERY IN AMERICA. — THE CORK LEG. — THE ARTIFICIAL LIMBS OF MODERN TIMES. — THE KNOWLEDGE GAINED BY EXPERIMENT. — THE UNION ARTIFICIAL LIMB COMPANY OF PROVIDENCE, R. I.

In the increasing progress of civilization, the tendency of which is to secure for mankind better conditions for comfort, health, and the development of all the complex human faculties, there is no special department the advance in which presents a more satisfactory record than surgery and the modern inventions which are allied to it, and designed to remedy, as far as possible, the injuries which, of necessity, surgery produces.

Physically, as morally, man stands at the head of creation, and in his physical organization, the specialization of the functions of his organs, and their mutual interdependence, together with the importance of each of them to the well-being of the whole, are carried to the farthest point. In the lowest form of animal life, the zoöphites, which consist merely of a sack for receiving food, if an individual is turned inside out he continues to live, and his new stomach performs its operations with apparently equal ease. The hydra has been divided into numerous parts, with the only effect of making as many separate animals as parts into which the single individual has been divided. Many varieties of worms may be divided in the same way, each of the parts becoming soon as perfect an animal as the original specimen. Crabs and other kinds of shell-fish, with many insects, reproduce the legs they lose; but, though this power of healing injuries is possessed in

kind by the higher animals, yet they possess it in a diminished degree, according to the increasing perfection of their organization, the greater specialization of their organs, and the greater interdependence of their parts.

In many of the savage tribes, who lead hardy lives, living upon simple food and taking constantly vigorous exercise, very severe wounds are cured by simple natural processes, so as hardly to leave a scar. Nor are similar instances unknown in civilization, where the individual, by the same course of life, has possessed the same degree of health.

But, unlike the crab, the human body cannot replace, by a natural process of growth, a leg which has been lost by accident. It is upon the superior character of the human brain, and the consequent ingenuity and invention of the race, that man has to depend for the means of supplying the loss of any such important organ in his animal economy; and for the success already attained in this branch of industry the present generation may well congratulate themselves.

The practice of surgery was early established among the Egyptians, and among them was a privilege of the priests. The custom of embalming the bodies of the dead, in which process they were opened, gave opportunity of becoming acquainted with its constitution. On the ruins of Thebes, according to the authority of Kenrick, in his *Ancient Egyptians under the Pharaohs*, "basso-relievos have been found displaying surgical operations and instruments not far different from some in use in modern times."

Herodotus, who visited Egypt during the fourth century before the Christian era, has left us, in his account of that country, a description of many of their manners and customs. In this work he speaks of many of their surgical operations, and makes mention of their appliances. From this some writers have supposed that he describes their use of artificial limbs. Though it is most probable that the Egyptians made no use of such artificial limbs as have been introduced during the last thirty or forty years, yet it is quite probable that they invented and used some appliances which would enable a person who had lost a leg, for example, to walk about with more or less facility. For a people who had arrived at sufficient surgical knowledge to cut off a leg, the conception would not be difficult of supplying it with something like

a wooden stump, or else with crutches, by which locomotion would be possible.

But, in common with all the nations of antiquity, the Egyptians, as far as our information of them goes, knew nothing scientifically concerning the construction of the human body. They were debarred this knowledge by the fact that religious scruples forbade the dissection of the body; and thus, though they had a general conception of the various parts of the body, and of its internal arrangement, yet they knew nothing of the relative importance of its parts, or of their functions; and their surgical, like their medical practice, must have been purely empirical and experimental.

The Hebrews, during their captivity in Egypt, probably obtained some ideas concerning surgery; but, even at a late period in their history, they had greater confidence in the skill of the priests of Phœnicia, who were also surgeons, than in their own, for the treatment of wounds and fractures. In 2 Kings 1, 2, Ahaziah, wounded by a fall, sent to consult the priests of Baal-zebub whether he should recover. Other instances can be found in the same book, which show that the surgical knowledge of the Hebrews was very slight.

The Greeks early obtained a knowledge of surgery from the Egyptians, and, with their inquiring disposition of mind, added to it by inventions of their own. Æsculapius acquired, in the mythical period of Grecian history, such a reputation for his skill in surgery, that he was raised to the dignity of a demigod; had temples built in his honor, and was fabled to be the son of Apollo. Homer, in his poems, speaks of his two sons, Podalirius and Machaon, as companions of Agamemnon during the Trojan war, who rendered great service to the Greeks in dressing their wounds. The first of these he praises for his skill in blood-letting, and the second for his skill in dressing wounds. Despite, however, the presence of these divinely descended surgeons, it would appear from Homer that fractured limbs were considered beyond their art, and in such cases the poet invokes only the aid of Apollo himself, making no mention of the possibility of human aid therein.

For centuries, however, among the Greeks the practice of surgery was retained as a monopoly in the family of the descendants of Æsculapius, who were known as the Asclepiades, and who had schools of medicine established at Rhodes, Cnidus, and Cos.

About the sixth century before the Christian era, Pythagoras established at Cretona another school of medicine. One of his pupils, Damocedes, saved his life, when taken prisoner by the Persians, by setting a dislocated ankle for Darius after the Egyptian surgeons had failed to do so. The next distinguished name in the annals of Grecian surgery is Hippocrates. To perfect his knowledge of the anatomy of the human body, the dissection of which was forbidden, he dissected those of apes, as being the animals most nearly approaching the human form.

In the third century before the Christian era, dissection was first introduced in the school at Alexandria which was founded by Ptolemy Soter. The surgeons who introduced this necessary appliance for the study of anatomy were named Herophilus and Erasistratus, and the world owes much to the knowledge they thus gained.

In ancient Rome the first great name we meet in the annals of surgery is that of Celsus. Among the subjects spoken of in his writings we find the process of tying the arteries, when they were wounded, with remarks upon dislocations, fractures, and amputations of the limbs. Before the Christian era other distinguished surgeons appeared in Rome, but their labors were not devoted to the special branch which occupies us.

With the advent of Christianity surgery degenerated. Again, the prejudice in the popular mind against the use of dissection, operated as an impassable barrier against the accurate and positive study of anatomy; while a new and perhaps a greater obstacle in the way of surgical progress was raised by the superstitious reverence for the relics of saints, with which the spread of the new religion became connected. It was impossible that surgery, or any branch of positive science, should be pursued, when adoration at the shrine of the supposititious bones of some hypothetical saint was universally believed to be the most efficacious means to be found for curing disease, or relieving an unfortunate from the sad results of some accident.

The first writer upon surgery who appeared in the first five hundred years of Christianity, who is worthy of mention, is Aetius, who lived between 500 and 550. His writings are both numerous and valuable, and yet he urges the importance and the efficacy of charms and amulets in averting or curing disease or accidents.

About the middle of the seventh century the Arabian surgeons

in Spain began to attract the attention of Europe by their skill and learning. The revival of Grecian learning began among them before it was known in Middle Europe. Rhazes, Avicenna, Albucasis, who invented the probang, Avenzoar, who flourished between 852 and 1100, are the chief names of those who acquired the most distinction while the dark ages still buried Europe in ignorance.

During this time the practice of surgery in Europe had, by degrees, fallen more and more into the hands of the priests, who were the only persons in the dense night of superstition who had some little knowledge; but, by the edict of Tours, in 1163, the practice of surgery was forbidden them, since it was supposed to call their attention away from the more important subject of spiritual healing.

For the next two centuries or so the practice of surgery degenerated, therefore, chiefly into the hands of the barber surgeons of Europe. At the hands of Andreas Vesalius, who was born in Brussels in 1514, the study and practice of surgery received the new life, and commenced the course of vigorous growth, which has characterized this study up to the present time. From his early youth his attention was strongly directed to anatomical studies, and he revived the practice of dissection, though he commenced it against all the prejudices of the time, and in face of the dangers of the Inquisition.

So strongly, in his own nature, did the modern spirit of inquiry battle with the restraining superstition he had inherited from the times in which he lived, that, it is said, he never commenced the dissection of a subject without first kneeling in earnest prayer to be forgiven for such a crime.

In 1543, when only twenty-eight years old, he published his great work, in folio, entitled *De Corporis Humani Fabrica* — the Fabric of the Human Body. In this work, which opened the modern era of surgery, he took persistent and strong ground against the superstitious reverence for antiquity; and so admirable has been its effect, that it has been well called "the discovery of a new world," and "an immortal work, by which all that had been written before was almost superseded."

The world was ripe for the new era, and about the same time Fallopius and Eustachius, with, soon after, Paré, in France, appeared to take part in the great work of establishing surgery upon the positive and scientific basis of dissection. To the last

of these belongs the honor of having revived the process of tying the arteries after amputation. Up to this time, during the middle ages, the stoppage of the blood was produced by cauterization with a hot iron, and the application of tar, or boiling oil. In many cases the severing of the limb was performed with a red-hot knife, in order to cauterize the flesh as soon as the cut was made. This method is a fair sample of the cruelty of the methods then employed in all the operations of surgery. It would seem almost as though it was thought that the more the patient was made to suffer, the greater the credit which belonged to the operator.

During the seventeenth and eighteenth centuries many distinguished surgeons flourished in Europe. The simple mention of their names would occupy too much room here; but the tendency of the practice of surgery began to be turned towards the methods of alleviating suffering; and, towards the beginning of this century, conservative surgery, or the theory of preserving, as far as possible, the injured parts, began to replace "heroic surgery," or the too prompt use of the knife. To the American surgeons belongs the chief credit for the inauguration of this new method, and many of its processes are peculiarly our own.

In the United States, before the Revolutionary War, our surgery was only a reflex of that of the mother country. The exigencies of that struggle, however, developed the talent which had before been lying hidden for want of an opportunity; and since that time American surgery has had an independent growth, and been recognized throughout the civilized world for its contributions to the knowledge, and the appliances for lessening the dangers and the sufferings, of disease and accident.

Among the numerous improved methods and discoveries which the world owes to the invention of American surgeons, the use of chloroform and other anæsthetics, and of artificial limbs, are, perhaps, the most noteworthy. The present perfection of these last is due entirely to American genius. From the times of Herodotus to the beginning of this century, the unfortunate patient who had lost a leg would find in the whole world no appliance to replace it but a wooden stump and crutches.

The idea that it was possible to replace these clumsy and inadequate means of locomotion with an artificial leg, which would enable the owner to walk, dance, run, skate, or do anything with one or even with two artificial legs which he could do with his natural ones, even as late as fifty years ago, appeared to be the

absurdest visionary dream—an attempt to realize the poetic vision of the famous "cork leg," which formed the basis of the song concerning the fate of Mynheer Von Flam, "the richest merchant in Rotterdam," who, having lost his leg, had it replaced by an artist who

> "had made cork legs his study and theme:
> Each joint was as strong as an iron beam,
> And the springs were a compound of clockwork and steam."

Having tried on his leg, however, it ran away with the unfortunate merchant; and, though he tried in every way to stop, and even

> "flung himself down to stop its pace,
> But the leg got up and continued the race."

So that to this day, as the song informs us, he is still dragged unwillingly in his journey over the world.

It would seem that the poets who have sung the artificial leg had lost the original prophetic character of their profession, since not only in this ballad, but in Hood's story of *Miss Kilmansegg and her Golden Leg,* the new limb proved the death of its possessor, Miss Kilmansegg having had her brains dashed out with her leg by a burglar who was attracted by the solid gold of which it was composed.

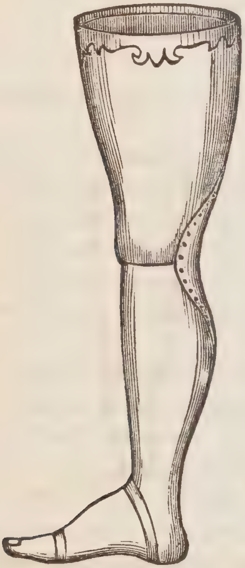
The history of the improvements in artificial limbs belongs entirely to this century. The first were made of cork. Though the first contained many improvements upon the old "peg leg," or wooden stump, yet they were far from perfect.

The number of men wounded in the late civil war, and the generous policy of the government towards them, so increased the demand for artificial limbs that numerous inventions were patented in this direction. The materials used in these various inventions have been wood, leather, sheet iron, tin, zinc, raw hide, rubber, and a combination of these, with other materials, the compositions of which are the inventors' secret. The combinations of these various legs have been intended to secure ease and security in the motions, and to imitate those of nature as closely as possible; but, as is usual in all inventions, the first methods used for this purpose have been clumsy, and, on trial, have been found imperfect.

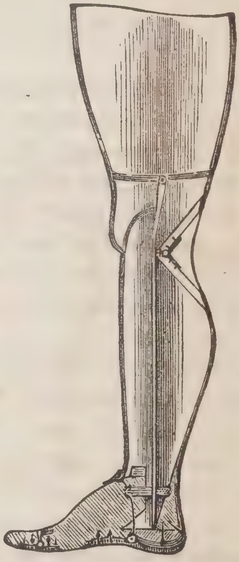
It is only thus by experiment and observation that the knowledge can be gained of what are the requirements in such cases,

and what means shall be taken to make an article which shall be perfect in all respects — strong enough without being too heavy; so articulated as to work easily, and, in its natural movements, imitate the action of walking; while, at the same time, its motions are secured by a mechanism which will not wear out easily, but will be permanent.

In the artificial legs made by the Union Artificial Limb Company of Providence, R. I., these qualities are so admirably attained by simplicity of arrangement, that it is not too much to say that they are perfect. The annexed engravings will illustrate the peculiar advantages claimed by the artificial limbs of this company, and the simple but effective methods they use to attain them.



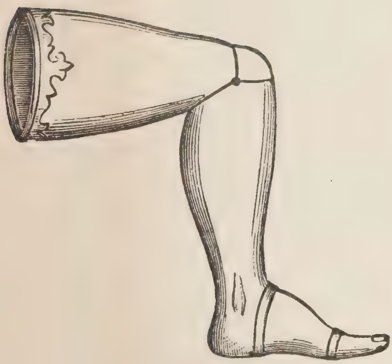
No. I.



No 2.

In the first place, by the use of Manilla paper as the material used in their manufacture, great strength is obtained with great lightness. (No. 1.) This company has often replaced legs of other material, weighing eight pounds, by one of their own weighing but little over two pounds. The importance of lightness in an artificial limb has been so uniformly proved by experience as to be now unquestionable. At first it was naturally supposed that the limb might approximate in weight the natural member which it replaced; but this has been found to be a great mistake.

Then, too, the construction of these legs is such that the weight of the body is brought directly to the ground through the heel, without the intervention of an ankle joint; imitating nature in this respect, and securing the advantage which the old wooden leg had over all the methods prior to this invention. Its mechanism for the knee and ankle joints (No. 2.) is also the simplest, using no metallic bars, bolts, or springs, so liable to become worn or broken by use. The knee joint works automatically, by a rubber spring working over a pulley, and, as will be seen from the sectional view, bringing the leg and foot into a natural position in walking, without any muscular strain upon the



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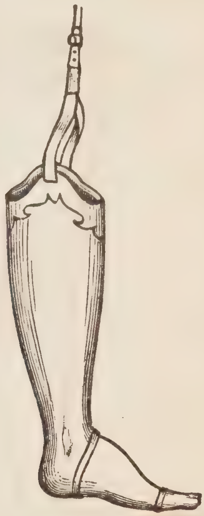


No. 4.

rest of the leg. The ankle joint works upon a new principle, giving the foot a rolling motion (No. 3.), like that of nature, so as to avoid the clapping sound, generally made in other legs, when the foot touches the ground.

The material of the leg is so manufactured as to be tough as horn, and entirely impervious to moisture, and insensible to the differences of temperature. As the leg is moulded upon a cast taken from the stump, it fits with perfect accuracy, and avoids the irritation which is frequently so objectionable from legs which do not fit perfectly. (No. 4.) The uniform testimony from those who have used the legs made by the Union Artificial Limb

Company, replacing with them, in numerous cases, the limbs of other manufacture, proves conclusively that, for use, these legs are as near as possible a perfect substitution for nature's handiwork; and it is a matter of congratulation that invention, guided by science, should have done so much to alleviate the loss by accident of so important a part of the bódy.

JEWELRY AND ITS MANUFACTURE.

THE LOVE OF PERSONAL DECORATION. — INSTANCES OF IT IN THE ANIMAL CREATION. — MAN SHARES IT WITH THE ANIMALS. — THE THEORY OF NATURAL SELECTION. — THE PHILOSOPHIC VIEW OF PERSONAL DECORATION. — THE JEWELRY OF EARLY NATIONS. — THE SAVAGE TRIBES OF TO-DAY. — DERIVATION OF THE WORD JEWELRY. — JEWELRY IN HISTORY. — IN MODERN TIMES. — THE AMOUNT USED IN THE UNITED STATES. — PROVIDENCE THE SEAT OF THIS BUSINESS. — THE CAUSES OF THE INCREASE OF PRODUCTION. — THE METHODS OF MODERN MANUFACTURE. — M. T. QUIMBY AND CO. — HISTORY OF THEIR SUCCESS. — THE MORAL EFFECTS OF JEWELRY.

THE love of personal decoration is a sentiment which man shares with the animals, as a record of his connection with them in the chain of creation, which binds all organized being into one consistent whole. In modern times, the naturalists of the Darwinian school have first, in the history of natural science, turned their attention to the effects of the various brilliant decorations of animals upon their success in the "struggle for life," and have already arrived at most valuable conclusions concerning it.

There is no longer any question that animals are sensible to the charms, not only of their brilliant natural colors, but that, also, many of them in a condition of domestication are equally delighted with artificial decorations. Elephants have been known to take great pleasure in having the points of their tusks ornamented with gilt metallic balls, and to be envious of others who surpassed them in this respect.

Numerous other instances of the delight animals take in artificial decoration can be found in the works of modern writers upon natural history, or must have been observed by those who are interested in observing the habits of animals.

The theory of natural selection, which is one of the best contributions of the modern spirit of investigation to the science of

natural history, has opened an entirely new field of inquiry concerning the causes for the brilliancy of the plumage of birds, the contrasting colors of animals, and their possession of various species of organs which appear to have no further use in their animal economy than to serve as decorations.

Although, too, this branch of inquiry is of such very recent date, yet the results it has already gained by observation go far towards affording a scientific basis for a philosophical comprehension of the physical reasons for this inherent love of personal decoration, which mankind shares equally with the animals.

In support, also, of this view, we have the testimony of the relics of the early dwellers on the earth, the inhabitants of the lake cities of Europe, and the remains of the races who lived during the stone age of human society. Of all these pre-historic peoples, the only records which have come down to us are their weapons and their ornaments; and the nearly equal proportions of these show most probably that, even at that early age, their inherent love of personal decoration asserted itself equally with their destructive tendencies, or their love of war.

But without this testimony, in the world of to-day, the savage tribes all show by their passion for ornaments, that personal decoration is one of the first developments in the course of our social evolution. It is a mistake, therefore, to object to the love of jewelry, though it is sometimes too inordinately displayed in modern times, or to attempt to seek a remedy for it by utterly destroying it. It is founded in nature, and, like all natural tendencies, cannot be eradicated, but should, by judicious appliances of general culture, be directed.

It is nothing against some of the ornaments worn at present, by ladies of fashion, that they resemble those worn by their barbarian ancestors. Those who use them are not necessarily barbarians; but the fact only shows that the love of ornament is inherent in human nature, while its manifestations take on the various phases of the increased culture of the time.

A lady who wears bracelets and ear-rings would be shocked by the suggestion that she should add to her attractions by wearing also a nose-ring, a lip-ring, or anklets; or that she should tattoo her face in fanciful patterns with brilliantly-colored dyes. Yet many of her contemporary sisters still use all these appliances of decoration, and from the same natural and inherent tendency for decoration, based upon the fact that our nature is eminently so-

cial, and we, all of us, desire to stand well in the estimation of our fellow-men.

In fact, in the very word *jewelry* we have made an unconscious vindication of its use. It is derived from the word *jewel*, meaning a precious stone, or an ornament in which precious stones are used, and, with the Italian *giojello*, the French *joyau*, the German *juwel*, and similar terms in other European languages, is allied with the root of the Latin word *gaudium*, joy, and was an instinctive expression of the pleasure naturally excited by the sight and use of jewels.

In the various museums of Europe and this country, the collections of the jewelry of various nations are most interesting and instructive. They afford the data for the study of the customs of nations which have passed away, leaving frequently behind them no fuller record of their lives than such as is contained in these collections of their appliances for personal decoration. From the polished and engraved bones worn as ornaments by the dwellers of the lake cities, up to the quaint but exquisitely worked golden jewelry of the Etruscans, the Romans, and the Byzantians, the gradual growth of the art can be traced step by step, and the different national characteristics of the various nations can be studied as accurately as in their architecture, or in any other records of their culture which have come down to us.

From the ruined cities of the East immense stores of jewelry and trinkets worn by the Egyptians, the Assyrians, the Babylonians, and other nations, have been found, and are now carefully preserved. From these, and from the jewelry of India and China, it is evident that the art of making jewelry was one of the first at which mankind arrived, and that the taste for personal decoration is a universal expression of human existence.

In modern times the improved processes of the arts, arising from the application of science to their methods, and the introduction of the use of machinery, has so cheapened and increased the production of jewelry as to place within the reach of every one the ability to gratify his taste for it.

In the United States the greater equality of our political conditions, together with the freer circulation of the results of industry, and the activity of our social life, has led to the almost universal use of jewelry.

By the report of the census of 1860, there was produced in the country jewelry to the value of almost eleven millions of dollars.

The extent to which this has increased during the last decade justifies the estimate that, with the importations from abroad, there are consumed in the United States at least twenty millions of dollars' worth of jewelry a year.

The chief seat of this industry is at Providence, R. I., which early assumed this position, and has kept it ever since. By the Constitution of the United States a periodic enumeration of the inhabitants of the Union was provided for, but, in the first of these, made in 1790, there was no record made of the various industries of the country. It was in 1810 that the first report upon the manufactories of the country was submitted to Congress, and though acknowledged to be defective and incomplete, yet in the census of this year the jewelry manufactory of Providence, R. I., is stated as employing about one hundred workmen, with a production amounting yearly to one hundred thousand dollars.

From this point, which was really one of considerable advancement for the time, this industry has increased until the jewelry trade in Providence gives constant employment to nearly twenty-five hundred men and women, at wages varying from one to five dollars a day.

The chief cause for this increased production lies in the improvement of the processes, and the application of machinery to them, by which the cost has been so much reduced as to make the consumption really universal.

One of the chief improvements in the modern manufacture of jewelry is the process of using a thin covering of gold in the manufacture of various articles, instead of making them of solid gold, as was formerly practised. The method of doing this is as follows: —

The gold of the required fineness is rolled out into a thin sheet, in a rolling-mill similar to those in use for working metals, and is then placed upon a sheet of a composition made of copper and zinc, the proportions of which are varied according as required, and then by heat the gold is slightly melted, so that it will unite firmly with the composition.

The two plates are then again subjected to the rolling process, and "broken down," as the phrase is, to the required thickness. The ductility of gold is such that it may be rolled, when pure, into leaves measuring in thickness the one hundred and forty-four thousandth part of an inch. One pennyweight of fine gold is sufficient to work into plates with a pound of composition. As the

plates may be reduced for practical use to the one hundred and forty-second part of an inch in thickness, the gold is reduced to about the thousandth part of an inch. A plate covered with this thickness of gold will not tarnish, but will remain permanently bright, and will stand the test of acids.

Before thus rolling out the plates, the bars of composition are planed by machinery, so as to make them perfectly true and clean, otherwise the gold would not adhere to them. Gold of twelve or fourteen carats will stain a little under the influence of acids, so that for the best work that which is purer is used.

Gold wire for various uses is drawn by taking a "stock plate," or sheet, plated with gold, and first rolling it into a cylinder by hand, then placing it into a machine called a "closing machine," by which it is carried through a series of round holes in a steel plate, diminishing in size, until it is made of the required fineness. The gold will continue on the outside, and thus a tube covered with it is produced as fine as desired.

When the plated plates have been rolled, they are annealed by a charcoal fire, remaining in it for eight to ten minutes, or until they are heated to a cherry red. Then the plates are polished, on the gold side, with rottenstone and oil. The plates are then cleaned with naphtha and sawdust, wiped clean, and then cut into pieces of the requisite size.

These are then stamped out with dies into the shapes required, according to the special articles it is intended to make. The work then is given to the "fillers," who fill up the "fronts" with block-tin and lead. This process is rapidly done, the filling being melted by a copper bar, and dropped into the fronts.

The work then passes to the chasing blocks, which are of wood, covered with a cement made of pitch, red lead, and black rosin, which affords a bearing strong enough, and yet sufficiently elastic, for the work.

Here the work is chased with pointed, steel chasing tools of various shapes, which are worked with small hammers. Then the work is again heated so as to melt the filling out entirely, and is then carried to a "cutting press," where the edges are smoothed off.

These "fronts" are then matched into the "backs," which have been prepared by machinery, and both are "trued" on their edges by an emery wheel. The fronts and backs are then soldered together, and given to workmen who scrape and finish

the edges. Then they are polished, and pass into the hands of the workmen who put the pins on the breastpins, bend the loops of the ear-rings, or do whatever else may be needed.

The articles are then washed with soap-suds and ammonia, naphtha, or alcohol, and dried in sawdust from box-wood, this being entirely free from acid.

Thus prepared, the articles are then arranged on cards, ready to be sold.

Shell jewelry is made from tortoise shell. This material is first soaked for forty-eight hours in warm water, and then shaved, cut into pieces, which are joined together until the requisite thickness is obtained, and then carved by hand, or inlaid with gold. In this last process gold wire is pressed hot into the shell in any required pattern, and is then polished with "list wheels," made of layers of carpet stuff.

When thus polished, they are washed, and packed for sale.

Jewelry of this kind is also made with artificial stones of glass. Most of these imitations are imported from Europe.

One of the chief expenses of the manufacture of jewelry by machinery is that of the dies, which have to be made of steel, at great cost, and frequently renewed, to suit the changing fashion of the times.

The representative house engaged in the manufacture of jewelry by machinery is that of Messrs. M. T. Quimby & Co., whose factory is located at 26 Potter street, Providence, R. I., where they furnish employment to a great number of men and women, the main office for the sale of their products being at 14 Hanover Street, Boston, Mass. They have also a branch office in New York. This house cannot be called old, since the business, which owes its present importance chiefly to their enterprise, is itself of very recent date.

Having had a successful experience of about twelve years in the jewelry business, Messrs. Quimby & Co. commenced, in 1860, their present business of manufacturing jewelry by machinery. From the first their invariable rule has been to allow none of their work to be sold for anything but what it really is, and a strict adherence to this rule has resulted in the establishment of the well-known reputation of their wares.

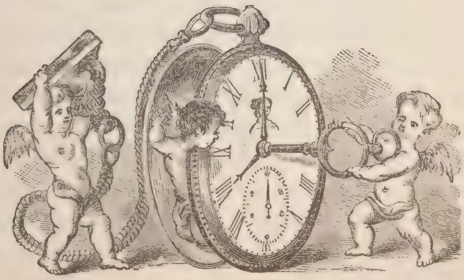
Though dealing largely in pure gold jewelry, and manufacturing it themselves, yet their chief business is making plated jewelry; and they have established the reputation of making the best of this which can be found in the markets of the country.

The house is composed of Mr. Munroe T. Quimby and Mr. Luman V. Quimby, who are natives of Vermont, and have carried into their special branch of manufacture the energy, the enterprise, and the probity which have extended the good reputation and influence of Vermont all over the Union.

Their wares consist of all conceivable ornaments known to the jewelry trade, and which unite decorative and artistic value with usefulness, affording to thousands the opportunity for indulging their taste for personal decoration, who would, without their aid, have been forever debarred the pleasure and the culture which come naturally from the gratification of our tastes and attractions.

In this view of the case, the manufacturers of jewelry are entitled to creditable consideration in any enumeration of the influences at work to increase the morality of the nation, by increasing its culture, in the only way that this can be effectually done — by enlarging the enjoyment and the happiness which comes from the gratification of our attractions.

The house of Messrs. M. T. Quimby & Co. imports heavily from all grades of foreign made watches, and keeps a full stock of all grades, as well of American manufacture, the whole being arranged in massive iron safes, and in so tasteful and business-like a manner, that it is well worth the time of one who has never been in a wholesale jewelry establishment, to visit the main office of this house, at 14 Hanover street, Boston, where his taste may be gratified, as well as his fund of information regarding the jewelry trade be enlarged.



STOVES AND RANGES.

THE INFINITY OF PATTERNS. — AMERICAN INVENTIONS AND IMPROVEMENTS. — DR. FRANKLIN, COUNT RUMFORD, AND DR. NOTT. — FROM THE FIREPLACE TO THE GRATE. — FROM THE GRATE TO THE STOVE. — THE FRANKLIN STOVE. — ANTHRACITE COAL. — DR. NOTT'S INVENTION. — DESIRABLE POINTS IN A PERFECT STOVE. — PARLOR PATTERNS. — HEATING BY STEAM AND HOT AIR FURNACES. — COOKING STOVES AND RANGES. — VARIETY IN SIZES AND PATTERNS. — STOVE FURNITURE. — HOW AND WHERE STOVES ARE MADE. — IMPROVED RANGES. — GAS STOVES.

It may be assumed that the ancient brazier, filled with live coals and set in the middle of an apartment, — a method of warming which ante-dated the fireplace and chimney, — was at least a hint for the manufacture of the modern stove. For the stove, whether for warming or cooking, is comparatively modern, beginning with the huge brickwork, and pottery, and sometimes porcelain-faced stoves of a century or two ago in Northern Europe, and in use, without essential modifications and improvements, in Russia, France, and Germany now. But with a vast variety of stoves made of cast and sheet iron, and an infinity of patterns and "improvements," the United States surpasses all other nations in their use and manufacture. Indeed, three Americans — Dr. Franklin, Count Rumford, and Dr. Eliphalet Nott, of Union College — were the pioneers in the invention of improvements, and the introduction of principles which are essential to the utility of any stove, of whatever style, now in common use in Europe or America.

From the old-fashioned fireplace, naturally the first steps in advance were such modifications of the fireplace as appear in the various forms of grates set in the fireplace, or in the "Franklin stove" and its more modern modifications. Count Rumford also applied the same principle to stoves, and adapted them for burning bituminous coal as well as wood. Franklin designed a stove for English use, to burn bituminous coal and consume its own

smoke, and which secured both warmth and ventilation. He also introduced the flues and regulating-valves for the admission and discharge of air, with a register, which, by closing or opening, would check or increase the draught to any desired degree. The open Franklin stove, for wood or soft coal, speedily became popular; but the introduction of close stoves was more difficult among people who had been accustomed to see the blazing fire. The yearly diminution of wood supplies for fuel, and the fortunate discovery of anthracite coal in the United States, stimulated Dr. Nott to the invention of an upright close stove, which for many years was almost universally used throughout the Northern and Eastern States, especially the larger sizes for warming halls in houses, churches, and public rooms. The "Nott stove," of different sizes, for a long period had a popularity that has attached, perhaps, to no other pattern, and it furnished suggestions for the more complete and perfect stoves of later introduction.

The desirable points to be secured in any stove are as thorough ventilation as is possible; control of combustion by means of flues and dampers; simplicity of construction; and economy of fuel. To attain all these points in perfection is quite impossible, even with the elaborate contrivances introduced of late years, and the intricate "improvements" which have increased the cost and unpopularity of certain kinds of "parlor stoves" in nearly equal proportion. It is known that with the best stove, heated cast or sheet iron vitiates the air by burning out its oxygen; and hence stoves for warming merely have been largely superseded by steam pipes and hot-air furnaces. Public buildings, manufactories, hotels, etc., are now almost universally heated by steam, and furnaces are common in private houses. Where stoves are necessary, the simpler forms, requiring the least manipulation for their management, and open stoves affording the best ventilation, are generally preferred. There is, and for many years will be, a large demand for what are called "parlor stoves," and with constant improvements in their construction, much artistic ability has been displayed in rendering them agreeable to the eye as tasteful articles of furniture.

In the manufacture of cooking-stoves, for wood or coal, America is in advance of all the world. To mention even the leading popular patterns would require a volume. From the largest ranges capable of cooking for a thousand guests in a great hotel, down to the miniature stove which cooks the food and warms the room of

the poor sewing girl, the American patterns already patented and in use may be counted by hundreds; and new designs appear every season. The great stove founderies are in Albany, Troy, New York, Boston, and Philadelphia; but there is scarcely a city of any size in the United States which does not manufacture these stoves, and their use throughout the country is universal. They are cast from the best mixtures of pig iron; are lined with fire bricks moulded to the shapes of the different patterns; they have holes or openings on top for pots, pans, and boilers, in number from two to four, six, or eight, according to the size of the stove; they are cast so exactly that duplicate parts of a particular pattern can be furnished at any time, and are completely supplied with tin or copper boilers, and other furniture, while competition in the business brings the best of these stoves within the reach of people of even limited means. An American household that is without a first-rate cooking-stove is poor indeed.

Great improvements have recently been made in cooking-ranges, and improvements are constantly making, which increase the capacity of the range without a proportionate increase in the consumption of fuel. Very simple and useful stoves, of cast and sheet iron, for cooking and for warming rooms, with gas as the only fuel, are also extensively manufactured and used in the United States.

FILES AND THEIR MANUFACTURE.

THE GREAT USE OF FILES. — THEIR ANTIQUITY. — THEIR SUBSTITUTES. — THE DERIVATION OF THE WORD. — CLASSIFICATION OF FILES. — THE PROCESS OF MANUFACTURE. — ANNEALING. — CUTTING. — HARDENING. — TESTING. — MACHINE-MADE FILES. — PREJUDICES AGAINST. — REASONS FOR THIS. — AMERICAN FILE COMPANY. — CHARACTER OF THEIR MANUFACTURE.

THE use of the file in the various operations of modern industry is much greater than is generally supposed. When we reflect, however, that there is hardly a branch of industry in which the file does not directly or indirectly enter,—since in most operations of smoothing or polishing the file is used,—we will be the more prepared to receive the statement that the estimated value of the files annually consumed, or worn out, in the United States amounts to an aggregate of six millions of dollars.

Under the microscope the smoothest polish produced by the art of man is found to consist of scratches which are too fine to be seen with the naked eye. This is the case with all polished surfaces which are made so artificially. Nature has methods of producing the same effect by other means, such as growth, which man cannot as yet imitate. The advantages of polishing the surface of weapons and utensils, and the greater beauty which they thus possess, must have early attracted the attention of mankind, and prompted ingenuity to invent some means of producing it. Among some of the still uncivilized tribes existing in the world, stones with a rough surface, or in some of the Pacific islands, bits of shark's skin are used for filing their weapons. Specimens can be found, in collections of such curiosities, of implements made by mounting the sharp teeth of fish between two pieces of wood, producing thus a file which must prove quite effective, especially among a people whose time

is all leisure, and where the inexorable test of money does not prevent their spending weeks in doing what the civilized man must do in minutes.

These various substitutions for files require, however, that they shall be applied only to the working of wood. With the introduction of the metals the necessity arose for some utensil of a texture hard enough to cut these, before men were able to file them.

Most probably, as the use of the metals is older than any recorded history, the use of the file has been almost equally as long in the world. The pictorial decorations discovered in Thebes, and which date at least to a period four thousand years ago, represent butchers sharpening their knives upon what are supposed, from the blue color, to be steel sharpeners. That a kind of file, adapted to sharpening edged tools, was in use in antiquity, appears from a passage in the Bible. In 1 Samuel, chap. 13, v. 21, we read, "Yet they had a file for the mattocks, and for the coulters, and for the axes, and for the forks, and to sharpen the goads." This passage shows that files were then used for sharpening tools, and that consequently they must, if made of metal, have been hardened.

Among the Greeks and Romans the use of the file must have been quite general. They could not have arrived at the finish of their metallic castings without the use of some such instrument. Our word *file*, as applied to the tool known under this name, is derived from the fact that the lines by which its teeth are formed are arranged in lines, or files, and with this meaning the same word can be traced through all the languages of modern Europe. The French word for a file, the instrument, is *lime*; but they have the word *file*, meaning an orderly succession in a line, while the Spanish, Portuguese, and Italians have the word *fila*, with the same meaning, being a derivation from the Latin *filum*, a thread. The Anglo-Saxon word for a file was *feol*, the Old German *fila*, while the Modern High German is *feile*, the Dutch *vyl*, and the Danish and Swedish *fil*. The similarity of these terms, diffused among so many various peoples, shows that the use of the instrument dates to the period lying far back of all our historic records, before the nations of Europe had commenced their migration to their present habitations, from their old Aryan home, where some term was in use from which all the present modifications are derived.

In the present time the specialization of industry has been carried to such a point, and the uses to which the file is applied

have become so various and so different, that the different kinds of file have been classified, and file-making has become a very important branch of national industry.

The first division of tools for abrading is into files and rasps. When the teeth are formed by lines cut into the surface of the tool, and extending across it, the result is a file; but when the teeth are made by cutting into the surface with a narrow sharp-pointed chisel, which turns up the teeth in the shape of triangular pyramids, the tool is called a rasp, and is chiefly used for working down wood, or other soft materials. Files proper are classified according to the form of their teeth, or according to their fineness; and also from the varieties of their shape. When the teeth are a series of ridges, raised by the sharp chisel with which they are cut, running parallel with each other, and either at right angles with the length of the file, or obliquely with it, the file is called "single cut." When, however, this first set of teeth is crossed by another series, cut in the same manner, but in a different direction, the file is called "double cut."

In classifying files by the comparative fineness of their teeth, those which are coarsest are called rough; those of the next degree of fineness bastard; then second cut, smooth, dead smooth, and double-dead smooth, as they increase in fineness. In classifying files according to their shape, they are called flat, float, mill-saw, hand, half-round, round, four-square, three-square, etc.

The cross section of a flat file is a long parallelogram, and it tapers toward the point for about one third of its length, both in width and thicknes. It is always double-cut, and it is more used than any other for the general purposes of a file. A float file is precisely the same as a flat file, except that it is single-cut. It is used for filing turned work in a lathe. A mill-saw file is much like a float file, but is thinner, and made of a finer grade of steel. It is used for filing mill-saws, and steel generally. A hand file is made of the same shape as a flat file, but tapers only in its thickness, not in width. Only one edge is cut, the other being left smooth, or, as it is technically termed, "safe." It is double-cut, and is used almost exclusively by machinists. The half-round file is flat on one side, and rounded on the other. A cross-section shows a segment of a circle, varying the height of the curve, as the file is intended for different purposes. When nearly approaching a half-circle it is called a "high-back." It is generally tapered both in width and thickness, and is double-cut.

It is used by all classes of mechanics, and perhaps more generally so than any other kind of file.

The cross section of a round file, which is also called a "rattail," is a circle. It is generally tapered toward the point, and is double-cut. It is in general use among all mechanics, being very convenient for filing out holes and hollows. The section of a "four-square" file is a square, tapered toward the point, and double-cut. It is very generally used, but not to the extent of the round file. A "three-square" file has for its cross section an equilateral triangle. Its most general use is for filing small saws, both circular and hand saws. For this purpose it is made of a very high grade of steel, and its edges are slightly flattened and are cut. It is usually single-cut, and should have a regular taper from heel to point. Of the three and a half, four, and four and a half taper saw files there are probably more sold than of all other kinds of files together.

Besides the files of which we have spoken there are many others bearing technical names, such as "pillar," "slotting," "cant," "cross," "feather-edge," "knife," "warding." There are many other files made to special order, and which bear no technical names. In fact, there is hardly any other article used in the arts which takes so many shapes as the file.

"Rasps" are made in many different forms. The most common is the "horse rasp" used by blacksmiths when shoeing horses. These are cut on one side as a very coarse rasp, on the other side as a coarse file. In New England they are used with a tang or handle at one end; in all other parts of the country they have no handle, both ends being used alike. Wood rasps are like either a flat or half-round file, but punched with rasp teeth instead of file teeth. Cabinet makers' rasps are of somewhat the same shape, but thinner, and punched with very fine teeth. These two kinds of rasps are seldom or never hardened. There are also flat and half-round shoe rasps, in great variety, and many others found only among particular trades.

The sizes of files vary, from the little needle files used by jewelers, to twenty-four inch flat and half-round files used by marine engine makers, but the general range is from four to sixteen inches in length.

The rougher and coarser kinds of rasps are made sometimes from blister steel, since they are intended to be used only on soft material, such as wood, horn, etc.; but the best file manufacturers

use cast steel for everything they make, except horse rasps, and even for these the use of a special kind of cast steel is becoming common. Files for sharpening saws, and other partially hardened steel tools, are made of a high grade of cast steel; and for hand-saw files, double refined cast steel is used exclusively, by those who have proper regard for their reputation.

The steel, having been received at the file factory, rolled into bars of the various forms of which files are made, is cut into the proper lengths, and then carried into the forging-room, where it undergoes the first process in its course of transformation into files. The first process is called "mooding out," and consists in hammering the pieces, at a red heat, into file "blanks," that is, into the required shape of the file, the "tangs," or that portion of the file which is fitted into the handle, being first fashioned. Two men, or a smith and a striker, can, on an average, "mood out" about eighteen dozen of twelve-inch files in a day.

After being thus shaped and "tanged," the files are placed in the annealing furnaces. The object of this process is to soften them so as to be more easily cut. The operation consists of heating them to a red heat, in ovens, where they are kept at this temperature about twelve hours. The ovens being then closed, they are allowed to cool gradually. This cooling should be slow, the process taking about forty-eight hours, and, contrary to the generally received opinion, is the most important operation in the manufacture of files. It requires more experience and skill to properly anneal the "blank" than it does to harden the finished file. All the excellence of the file depends upon its not being so spoiled by underheating or overheating in the annealing, that all the work of the subsequent processes is thrown away, since no subsequent process can remedy any defect arising from error or oversight in the annealing. Consequently this process is placed directly under the supervision of the most experienced and skilful person in the establishment.

When the "blanks" are considered to be sufficiently softened by the annealing process, they are taken out and straightened, if necessary, by the use of hand hammers, and are then ground upon large grindstones, driven at a high rate of speed. The chief purpose of this grinding is to perfectly remove all traces of the scale from the blanks, and it is continued until the entire surface is made level and bright, each spot or unevenness being ground away. The blanks, being thus prepared, are then carried to

the cutting shop, where those which are to be worked into the finest grade of files are subjected to a further operation, called "stripping," which consists in filing them in a peculiar manner; the object of which is to make the surface still more even. Then the files are ready to be cut.

In this process, as it is carried on by hand, the workman takes a blank, and resting it upon a piece of lead, on an anvil, cuts the rows of teeth with a chisel, which he strikes with a hammer. According as the teeth are to be fine or coarse, he uses a lighter or heavier hammer, and strikes a lighter or heavier blow. Experience and practice are his only guides in striking the blows of the required force, and always of the same force, so as to cut the teeth to an equal depth. The chisels used for this operation are very short, in order to have the requisite stiffness, and for being held conveniently in the fingers of the left hand. They have an edge wider than the file to be cut, and the angle at which they are sharpened varies, according to the kind of file to be made, from 10° to 40°. The "blank" is held by a strap at each end. The chisel, being placed upon the blank at the farther end, is inclined from the person at a small angle from the perpendicular, and is struck sharply with the hammer held in the right hand, a groove being thus cut in the face of the file. A ridge of steel, which forms the tooth, is raised up. Then the chisel is brought forward, and being slid from the operator until it reaches the ridge just made, the position of the next cut is determined, the blow is given instantly, and another ridge is made. The blows and cuts thus succeed each other at the rate of sixty to eighty each minute, their being parallel and of uniform depth being secured by the guiding ridges, and by the uniformity in the force exerted.

The hammers for the coarse files weigh from seven to eight pounds, while those used for the finest files weigh sometimes as little as one or two ounces. It is evident, therefore, that the skill required for striking with a regular uniformity of force can be acquired only by great practice, and then only by those whose natural faculties fit them for such precise work. When the file has been cut once, then for double-cut files, the operation is repeated, the chisel being so held that the ridges shall cross each other obliquely. The process of cutting the first set of teeth on a double-cut file is called "over-cutting," and of the second set, which cross the first, "up-cutting."

Formerly the majority of the files were cut "rough," but the

use of planing-machines, for metal work of all kinds, in modern times has led to the almost total disuse of rough-cut files for metal work, so that now the majority of files are bastard cut, which is found to be quite coarse enough for the work required. Second-cut and smooth-cut files are generally used only in machine shops, and are intended to follow and complete the work of the bastard-cut files. The surface left by a dead smooth file amounts almost to a polish.

The files, when cut, are then to be hardened. This is a process requiring care, but is not, as generally supposed, the most intricate one of file manufacture. The files are heated to an even red heat, and then cooled suddenly by being plunged into cold water. As it is necessary to protect the teeth of the file from becoming oxydized by contact with the atmosphere while they are heated, the files, before being heated, are covered with a paste, which is intended to protect the teeth from contact with the atmosphere. The chief ingredient of this paste is flour.

The mixture of the paste used to cover the files is in a measure a trade secret, and each operator varies it according to his own ideas, considering the state of the weather, the kind of steel in the files, the manner in which the teeth are cut, and so on. As yet the constitution of the paste, based upon a scientific analysis and a positive knowledge of the effects of its ingredients, has not been arrived at, and the process is still dependent for success more upon individual skill and experience than upon accurate rules.

The heating of the files is performed either in an open fire, like a common smith's fire, or by plunging them into a bath of melted lead, which has the further advantage of more effectually protecting the teeth from the action of the air. Sometimes, also, the files are heated in an oven into which the blast of a furnace is introduced. The file must be heated uniformly, from the tang to the point, to a cherry red.

After the file is heated properly, in order to harden it as much as possible, it should be cooled as quickly as possible. This is sometimes done by plunging it into water, but brine made of common salt has superseded almost everything else for the cooling of files; although clear cold water will make a file nearly as hard as brine, yet files so cooled "run," that is, bend and twist, so as to become useless. Besides, there is no doubt that water holding in solution any kind of salt will harden steel more

than clear water will. Some kinds of salts in solution will make steel so hard and brittle as to effectually spoil it.

The file is withdrawn from the bath into which it is plunged to cool it, before it has become cold throughout its entire substance, and while the inside of it is still warm, and is examined to see whether it is straight. If it is bent, it is then straightened; it having been found that this is easily done while the inside is still warm, without any danger of injuring the surface.

The files, being then cleaned from the paste which remains upon them by being scrubbed with diluted acid and sand, are placed in a vat of lime water to prevent their rusting. The files, being then finished, are tested.

This is done after taking them from the lime water and oiling them, by rubbing the entire surface of each file with a piece of steel, the hardness of which varies with the file to be tested. The files intended to be used on steel, and especially those to be used on saws, are tested with a "prover," as it is called, made of hard steel. If the file has any soft spot in it, the prover will slip over this place, instead of being cut by the teeth, and the file is then rejected. The testing of files is an important process in their manufacture, and any which will not stand the test are rejected by every manufacturer who has a pride in the reputation of his goods.

In the processes just described we have been dealing with files manufactured entirely by hand labor. Though file making is carried on very largely in England, yet the work there is done entirely by hand. Many attempts have been made to introduce machine labor, but heretofore they have been so uniformly unsuccessful that it is generally believed there that it is impossible to make a machine which will perform this labor, and statements of this kind are quite common in works upon this subject.

The difficulties in the way of making files by machinery are many and various. Though it would seem, at the first glance, that machinery would be peculiarly adapted to replace hand labor in this branch of industry, yet the technical obstacles have been found very difficult to overcome, and numerous inventions have, on practical application, proved to be perfectly useless.

The manufacture of files by hand process has been carried on in Sheffield, England, from the earliest periods of history, and to-day, in all the markets of the world, the chief supply of files is drawn from there.

Prior to 1840 the manufacture of files may be said to have been unknown in the United States. Probably some individuals who had learned the trade in England may, after emigrating to this country, have made a few files here ; but there was nothing like an organized business carried on in their manufacture. About 1845 the business of making new files, on a small scale, was organized at Matteawan, N. Y., by one John Rothery, an Englishman, who made excellent files, but conducted all the operations by hand.

In the United States, also, various machines have been patented to manufacture files by machine labor. One of these, patented by Captain Ericsson, was introduced into Sheffield ; but though it was found to do the work of nearly ten men, yet it was abandoned after a short time, on account of technical difficulties which it did not overcome. But finally the American File Company, at Pawtucket, R. I., who control in this country the use of a machine invented by M. Etienne Bernot, a Frenchman, have successfully established the production of machine-made files, and by the steadily increasing favor with which their wares are received, bid fair to soon supply the demand for this country with an article of home production, and, as they also control the use of the same machines in England, to make the business one of export also. In fact they have solved the problem of cutting files by machinery, and with equally good material produce a file better than those cut by hand. This fact is shown by the steady increase of the demand for files of their make, which are rapidly destroying the prejudice which our consumers, in common with those of England, felt against machine-made files.

There was a good reason for the existence of this prejudice, since, heretofore, sufficient care was not exercised in the selection of the material from which machine-made files were produced ; so that the consumers, finding the files poor, laid the blame of this, not to the poorness of the material used, but to the process by which they were made. Another reason for this prejudice lay in the fact that the machine-made files have generally been produced by capitalists, who were not practically acquainted with the processes necessary to the production of a superior article, and have failed to connect with them those who had this requisite knowledge. Besides this, the unusual demand for files during the late civil war led to the flooding of the country with inferior articles.

But the wares produced by the American File Company may challenge comparison with those of any country or of any process,

since their material is selected from the best, and all the operations are carried on with scrupulous care. Their files have supplanted the English ones in many of the largest machine shops of this country, while their machines have received the first-class medals of both the English and French international exhibitions.

The claim made by the American File Company that their files are as good as the very best, and better than the average of hand-made files, has not only been substantiated by the experience of many of the largest consumers and best judges of files in this country, but is further based on good reasons, since, in addition to the fact that only the very best steel known to the trade is used in the manufacture, only skilled and experienced men are employed in all the preparatory processes, and all the files are subjected to the severest tests before being sent out. The only change, also, made in the manufacture from the best English methods is that the sure and regular action of machinery is used to strike the blow that drives the chisel into the steel to form the tooth, instead of the changeable and irregular action of the hand. The very same utensil — a sharp chisel — is used to make the tooth; a machine-driven hammer, instead of a hand-driven one, strikes it. The consequence is that every tooth is the same height as the one next to it, and consequently *every tooth cuts*.

In a hand-made file, the height of the teeth vary, and often differ very much. It has been claimed that this difference is an advantage, since, when all the high teeth are worn down, then the low ones come into action; but this cannot be so, for the worn-out teeth must keep the low teeth off of the metal, and in fact place it in the condition of the bit or chisel of a carpenter's plane which is not driven far enough out from the face of the plane to reach the wood.

Every tooth in a well-cut machine file does its work, and when worn out it is *all* worn out. This is observable in a mixed lot of machine and hand-cut files, in which the latter will show many places hardly worn at all, and others worn smooth, while in the former every tooth will show the same amount of wear. This fact is very easily tested by taking the end of a piece of steel, and rubbing it with a firm pressure from the point to the heel of a machine-cut file: it will be seen that every tooth has upon it a slight shaving of steel, whereas, if the same test is made with even the most evenly cut hand-cut file, there will be found many teeth — very many — without the shaving adhering

to them; and the wider the piece of steel used as a prover, the more teeth will be found without the shaving.

A machine-cut file, therefore, other things being equal, will do more work and last longer than a hand-cut file. Other incidental advantages of the use of the machine process are, that files are cut five or six times as quickly as by hand, and the substitution of unskilled for skilled labor. It is found that care and attention in the workman are of more importance than any other qualifications whatever in cutting files by machinery.

The success of the American File Company in making the best files will, no doubt, work a revolution in the business; for, while there will always be a limited quantity of special files cut by hand, yet ninety-five per cent. of those used are of recognized sizes, shapes, and cuts, and will be made by machinery. The question is now merely one of time, since that of the capability of machinery to do the work is solved.

QUILL AND METALLIC PENS.

ANCIENT PENS. — REEDS AND PAPYRUS. — QUILLS AND PAPER. — THE GOOSE-QUILL TRADE IN EUROPE. — QUILL PEN MACHINES. — INVENTION OF STEEL PENS. — FIRST PATENT FOR THE PROCESS IN AMERICA. — JOSEPH GILLOTT, OF BIRMINGHAM. — COMPETITION AND CHEAPNESS. — PROCESSES OF THE MANUFACTURE. — STEEL PEN MAKING IN THE UNITED STATES.

Pens of some sort have been in use since the discovery of the art of writing with colored fluids upon papyrus. Previously, in making characters on wax or other tablets, a metallic pointed instrument was used. The first pens were made of hollow reeds, which are still used for writing in many Eastern countries. When paper followed papyrus, quills succeeded reeds as pens. The demand for these pens created a very important trade in Russia, Poland, Germany, and Holland, where great flocks of geese were raised mainly for their quills, which were exported in large quantities to England and other countries. Many writers still use quills only, and for engraving, and some other kinds of writing, they are preferred to other pens.

The quills, when picked, are assorted; the outside skin is removed by a hot sand bath, and subsequent scraping; the barrels are hardened by dipping them in a solution of alum or nitric acid, and they are then put up in bundles for market. By an ingenious hand machine, which makes a pen at one operation, large numbers of ready-made quill pens are manufactured and put up in boxes. Pens of the size and shape of common steel pens are also cut from imperfect quills and pieces, and the hand pen-maker, which is little larger than a pocket knife, is a useful instrument for quill writers, who are not skilful in the use of the penknife.

There is still, especially in Europe, a very large trade in quills, though those of the best quality are scarcer and much higher-priced than they were a few years ago. The invention and general

introduction of metallic pens has nearly driven quills out of common use — the new pens save the time consumed by the writer in making, and they are infinitely cheaper. The days, within the memory of people now in their prime, when the writing-master went from pupil to pupil in the school-house, to make or mend pens, have gone by forever.

The first steel pens were introduced in England in 1803; but they were slow in gaining the favor of people accustomed to the more flexible quill. In 1810 a patent was granted in the United States to Peregrine Williamson, of Baltimore, for metallic writing pens — the first of the kind manufactured in this country. In 1822 Joseph Gillott, of Birmingham, England, began the manufacture of steel pens by improved machinery, and speedily took the lead in a trade which became a most important branch of manufacture. He was soon followed by many manufacturers, several of whom became quite celebrated for producing pens of fine finish, elasticity, and proper temper, and especially at prices which enabled them to sell a gross at about the same price demanded by the original inventor, only a few years before, for a single pen.

Improvements in the manufacture rapidly followed, with a great variety of patterns designed to give greater flexibility with the required stiffness, a free flow of ink or fluid, and various sizes, with broad or fine points, for different kinds of writing. A very popular form for a while was the barrel pen, in imitation of the quill, into which the holder could be inserted; and with the pens inserted into the holders, an infinite variety of holders were invented, some of them being hollow, and designed to hold a supply of ink for continuous writing without dipping, resulting in what is commonly called the "fountain pen."

Steel pens are made almost wholly by machinery. The metal is rolled into strips of the required thinness, from which the blanks are punched; presses punch the hole which terminates the slit and gives flexibility to the pen; the blanks are then annealed; the proper curvature is given by means of dies; they are then hardened by heating and plunging into oil; they are tempered, and are cleaned and polished by revolving them in a drum containing sand and sawdust; the nibs are ground on emery wheels; the slit is made in a press; the pen is then colored blue or brown, in a revolving cylinder over a charcoal fire; and the finished article is then put on cards or in boxes for market. Such hand processes

as grinding the nibs, which is done by girls, are performed with wonderful rapidity, and the pens of various patterns, some of them very superior, are now everywhere as common and nearly as cheap as pins.

England was first in the field with this branch of manufacture, and the cheapness of labor in that country, with the facilities for producing the proper metal for pens, enables the English steel-pen manufacturers to nearly cover the entire market. The difficulty of competing with the English manufacturers made the first attempts to establish the business in the United States quite unsuccessful, and much money was sunk in the enterprise. Even now the best metal is English, and prepared strips are imported from Birmingham and Sheffield; but there are now in Connecticut, Massachusetts, New York, and Ohio several steel-pen manufactories, which do an extensive and profitable business.

PRINTING INKS.

INGREDIENTS AND COMPOSITION. — OLD INKS. — THE PROCESS OF MANUFACTURE. — PROPERTIES OF THE BEST INKS. — COLORED INKS. — HOW THEY ARE PREPARED. — VARIOUS KINDS OF COLORS. — RUBRICATED BOOKS. — DEMAND FOR COLOR PRINTING. — INK ROLLERS. — SELF-ACTING INKING MACHINES.

Printers' ink is of very different composition from writing ink. The ingredients are linseed oil, in which a small quantity of black rosin is dissolved, mixed with lampblack and carefully ground. The linseed oil is boiled to a thick varnish, turpentine is added, and some manufacturers add indigo or Prussian blue to improve the color. The ink is of the consistency of thick molasses, or of boiling tar.

It is doubtful if any of the modern inks surpass, or are even equal to, those which were used when printing was discovered. There are Aldines, Elzevirs, Caxtons, and Graftons now extant, whose pages show ink which preserves its color as freshly as when first printed. In many old books the color of the ink is not black, but a very rich blue-black or purple-black. Printers' ink-making is an important branch of manufacture, requiring the very best materials, great skill in mixing, and the most careful grinding. The business demands capital and excellent machinery, and the qualities looked for in the best ink are blackness, thorough mixing and grinding, sufficient thickness, adherence to the paper and not to the type, and the property of drying quickly on the paper. Every manufacturer claims to have his own secrets of ingredients and processes, and ink of various qualities and at different prices is furnished for different purposes, from the commonest coarse hand-bill printing to the finest book work. Very superior qualities of ink are manufactured for cut printing, and for printing from bank note and other engraved plates.

Colored printing inks are as old as the art of printing, and they were first introduced to imitate the illuminated letters done by hand in manuscript books. Red ink, for the rubrics in missals, is seen in old printed copies, still retaining its vivid color. Of late years, printing in colors, especially in commercial and hand-bill work, has created a great demand for inks which show all the colors of the rainbow, and many more. These are supplied by the manufacturers, but many printers with a muller, marble slab, pallet knife, and can of printers' varnish, mix various colored inks for their own use — reds with vermilion, burnt sienna, lake, and Venetian red; yellows, from chrome, ochre, and gamboge; blues, from indigo, Antwerp, and Prussian blue; browns, from sæpia, bistre, and raw and burnt umber; greens, by mixing blues and yellows; purples, by mixing reds and blues; and neutral tints, by mixing Prussian blue, lake, and gamboge.

In preparing them, the color is first ground on a marble slab, then well mixed by the pallet knife with the varnish — thinly (i. e. with more varnish) if for coarse work, such as posters, and quite thick for small type and wood-cut work. In working two or more different colors, each color requires a distinct impression, and the nicest registration and justification are requisite. In what is called rubricated printing, where red letters or lines are inserted in the black text, special rubricated types are used, and the black impression is generally made first.

Lottery tickets, stock certificates, drafts, notes, cards, bill-heads, etc., have created a large demand for color printing, and no printing office is complete without a full assortment of colored inks, which were formerly very expensive, but are now furnished more cheaply than the printer can mix them for himself.

In the earlier kinds of printing, and for a long period, the ink was applied to the type by means of ink balls. The hand roller was the next improvement, and it insured a more equal distribution of the ink. The elastic rollers are made of glue and molasses, or sometimes of glue and honey, and are cleaned, when necessary, with lye. There are now several ingenious self-acting inking machines, which are so constructed as to be readily attached to the different kinds of printing presses.

PAPER HANGINGS.

SUBSTITUTES FOR TAPESTRIES. — ANTIQUITY OF WALL HANGINGS. — TAPESTRIES OF THE EAST. — THE FASHION IN FRANCE. — SILK AND CLOTH. — GOLD, SILVER, AND DIAMOND DECORATIONS. — THE ARRAS OF ENGLAND. — GOBELIN TAPESTRIES. — MANUFACTURE OF PAPER HANGINGS. — FIRST SALES OF WALL PAPERS IN AMERICA. — THE EARLIEST DOMESTIC MANUFACTURE. — INTRODUCTION OF GLAZED GROUNDS. — PRINTING BY HAND. — PRESENT PROCESSES. — CYLINDER PRINTING MACHINES. — LONG ROLLS OF PAPER. — GROUNDING. — PRINTING IN THE COLORS. — VELVET AND GOLD PAPERS. — EXTENT OF THE BUSINESS. — HOW PAPER SHOULD BE PUT ON.

WALL PAPER is the modern and economical substitute for the ancient hand or loom-woven tapestries, which have been used in many countries from the earliest times. Homer speaks of them, and the oldest Hebrew records describe the elaborate and costly hangings, "wrought in gold and silver, and in divers colors." Centuries ago, in Eastern countries, the walls of temples, palaces, and the houses of the rich were lined with silken and cloth hangings, which bore beautiful designs, and were often ornamented with diamonds and other precious stones. The fashion came into France with Christianity, and the records of the fifth century make mention of the rich tapestries in the churches. Shakespeare shows Polonius hiding, and Falstaff asleep, behind the "arras," the common name in England, in old times, for French tapestries, for which the town of Arras was celebrated. The Flemings, French, and Italians were rivals in this manufacture. Tapestry weaving was introduced in England in the reign of Henry VIII. Throughout Europe the most famous artists furnished designs, and historical and mythological scenes were reproduced in tapestry, with all the vividness and delicacy of the original painting. The celebrated Gobelin manufactory, established at Fontainebleau by Louis XIV., surpassed all others, and is still celebrated for the rich productions of its looms, and for hangings which those who live in palaces alone can afford to purchase.

But the manufacture of paper hangings brings within the reach

of all who desire to decorate their houses wall papers of all patterns and prices, from the plainest to the most elaborate, and from the cheapest to the most expensive. Where the invention originated is uncertain; but it was introduced in both England and France in the beginning of the seventeenth century, and in the middle of the next century cylindrical machines were making long sheets of paper for the purpose. The first sales of paper hangings in this country were in 1737 — probably cheap patterns imported from England, and largely used, as they are now in some parts of the country, for window-shades. But travellers in this country, a hundred years ago, make mention of the handsome cloth hangings, imported from Europe, and even from India, to be seen in the houses of rich merchants in New York and Boston. Booksellers were the first dealers in paper hangings, and the "stained papers," as the goods were called, soon drove the cloth hangings even out of the dwellings of the wealthy, as the wall papers had superseded the cloth and leather hangings in England.

The first mention of wall paper manufactured in this country was in 1765, and within twenty years from that time there were manufactories in Pennsylvania and New Jersey, and Boston establishments supplied Massachusetts and other states. All that could be made found a ready market, and immense quantities were imported from abroad, particularly from France, which appreciated the importance of the American trade in this article sufficiently to remove the export duty. In 1789 the manufacture in Philadelphia had reached a production of ten thousand pieces a month, which was considered enormous then, but which would scarcely be a day's work for some establishments now.

The paper of domestic manufacture, however, was of inferior quality. The first patterns, with glazed grounds, were made in the United States in 1824, and soon after the best French designs began to be imitated. The growth of the business was very rapid, and the wall papers were popular everywhere, giving, as they did, a neat and pleasing covering to plain plaster, much superior to whitewash, and cheaper than hard finish or paint. From small beginnings, the business has grown to be prominent among the manufacturing interests of the country, and Yankee ingenuity has devised improved processes, which have been eagerly adopted abroad, and which have superseded slower processes still pursued in England and France.

The process of making paper hangings is similar to that of calico printing, or, it may be said, that for the production of the more elaborate patterns requiring many colors, the process is not unlike chromo-lithography. At first, the paper was made in sheets not more than thirty inches long, which were pasted together, and the printing was done by hand, block after block, each with its own color, being printed in succession. The introduction of new paper-making machines gave rolls of from one thousand to two thousand yards in length, and from twenty to forty inches in width. In 1843, an American machine was invented for printing two colors, and ten years later one which would print six colors, while now there are machines which will print twenty or more colors in one operation. Great improvements have also been introduced for expediting the drying and finishing the sheets.

The first step in the process is the preparation of the designs, which, as the finished papers show, demand artistic talent of a superior order, and afford abundant opportunity for the display of a refined and cultivated taste. Maple or pear wood is used for the patterns, and these, when cut, are inlaid with brass and felting, to make the blocks more durable. The color department is generally in the basement of the building, and there all the colors are mixed in vats, in which the mixers are driven by machinery, excepting some of the finer tints, which are mixed by hand. From the basement the colors are hoisted to the top floor, where machines cover the paper with the selected ground upon which the other colors are to be printed. On the first, second, and third floors are the cylinder machines which print the patterns. With a roller for each color, these machines print as many colors as the pattern requires, and the sheet, coming from the press in a continuous length, passes over steam-heated pipes, which instantly dry it, and it is then carried to reels, which roll it in readiness for the warehouse. The rapid working of these presses enables some of the more extensive establishments to turn out nearly eight hundred miles of printed hanging-paper every week, amounting in weight to more than two thousand tons in a year.

Some of the finer descriptions of paper are still printed by hand, particularly the gold and velvet patterns, for which some manufactories employ thirty or more hand-presses. A satin or highly-polished surface is given by machinery to the ground of some papers before they are printed with the patterns. For gold and

"flock," or velvet papers, the pattern is printed with glue size, and then with varnish or gold size before the flock or bronze is applied. The flock is ground and colored cloth or wool, and is dusted on the pattern before the glue and size impression is dry, and for bronze a machine lays on the material, while rollers remove the superfluous bronze. There is an almost infinite variety of patterns; new designs are constantly appearing; and the American papers, in beauty of design and perfection of finish, fairly compete with the finest specimens manufactured in Europe.

The progress in this manufacture in this country has been enormous. Single large establishments in New York, Boston, and Philadelphia employ as many as two hundred operatives, and manufacture five thousand tons of wall paper per year. In the American manufactories all the latest modern processes for printing, with American-invented machinery for coating, glazing, and finishing, are seen in operation, and processes which are still performed by hand in the foreign establishments, in this country are effected by steam-propelled machinery. The sales from manufactories, which a short time ago made but a few thousand dollars' worth of paper in a year, now annually amount, in single establishments, to more than a million dollars. New, more elaborate, and more beautiful patterns are constantly introduced; the invention of new machinery keeps pace with the manufacture; and the American improvements in processes are generally, though slowly, adopted abroad.

In putting paper on a wall, the primary essentials are good workmen, paste made from sound flour, and a properly-prepared wall. All the inequalities should be levelled, and, if necessary, the wall should be battened and canvased. If then a strong brown paper is applied, a ground is furnished on which the pattern paper may be smoothly hung.

FIRE PUMPS.

THE EFFECT OF GRAVITY ON LIQUIDS. — HOW THE ANCIENTS OVERCAME IT. — PUMPS AMONG THE EGYPTIANS. — WATER RAISING IN THE EAST. — AMONG THE GREEKS. — AMONG THE ROMANS. — THE SUCTION PUMP. — GALILEO'S REFLECTIONS ON IT. — DOUBLE-ACTING PUMPS. — FORCE PUMPS. — ROTARY PUMPS. — THE MOST EFFECTIVE KIND. — ITS CONSTRUCTION. — FALES, JENKS AND SONS. — HISTORY OF THE FIRM. — DESCRIPTION OF THEIR MANUFACTORY.

THE constancy with which all liquids tend to flow downwards has in modern times been found to result from the persistent action of the attraction of gravitation, and to be only a part, in the great economy of nature, of the constancy of motion, upon which all the phenomena of organic life, as well as those of the material universe, depend.

The falling rain, the babbling brook, and the mighty cataract, are each of them, to the modern scientist, as evident manifestations of the heat of the sun, the source of all energy and motion on the earth, as is the grass or the tender foliage, which, like a wave of green advances yearly round the world, as in its revolution round the sun it changes the relative position of its surface to that source of heat and life.

Among the ancients the methods in use for overcoming the gravity of water, or, in other words, for pumping it, were as rude and imperfect as their knowledge of the causes of its descent, or of any of the laws of hydraulics. In this branch of industry, as in every other, mankind commenced their course of progress by depending entirely upon the strength of their own muscular energy for the performance of any work required.

In fact, too, until invention had suggested some method of making a vessel capable of containing water, any attempt to overcome its gravity was impossible; but when men could make

buckets, they soon found that they could carry water in them, and it was by their use that the elevation of water was performed in early times.

Wilkinson, in his *Manners and Customs of the Ancient Egyptians*, says that instruments resembling portable pumps are frequently seen in the sculptures of the Egyptians; but it is most probable that he is mistaken in supposing that the delineations were intended to represent pumps. In the first place the representations in most of the Egyptian sculptures are not always realistic, but frequently merely conventional, and, therefore, might be easily mistaken for something else than what they were really intended to represent; and especially would this seem to be the case in this instance, when we know that nations whose commercial and other relations with the Egyptians were quite intimate knew nothing of the pump.

It is hardly to be expected that so novel and striking an appliance as a pump would be to any one who had never seen any such thing should have escaped the notice of Herodotus in his visits to Egypt, or should have passed utterly out of existence without being imitated by some nation of antiquity.

Among the nations of the East, who have a wonderful stability in their conservatism of ancient methods, the appliances in use for elevating water are chiefly a wheel, with buckets upon its periphery, and the pole and bucket, such as has always been in use in New England, and is still to be seen where the well-sweep has not been swept away by the besom of progress.

The Greeks used the appliance known as the Archimedean screw, so called from its inventor, Archimedes, in which water can be raised in a tube shaped like the threads of a screw, by inclining it to the surface of the water, and revolving it. Though the Romans used pipes for the introduction of water into their dwellings, and had even siphons, yet they were unacquainted with the fact of the pressure of the atmosphere, and that by this force water may be raised in a vacuum to a height of about thirty feet, or the height at which a column of water will equal the weight of a column of air of the same transverse area.

When the use of the common suction pump was introduced is not known. In this arrangement a tube is furnished with a plunger provided with a valve opening upwards. One end being placed in the water, the plunger is worked, exhausting the air, and the water, being pressed up by the weight of the atmosphere

acting upon its surface in the reservoir, is raised by the successive strokes of the plunger. The explanation for this apparent contradiction, on the part of water, of its usual tendency to flow only downwards, was, up to the time of Galileo, found in the dictum that nature abhorred a vacuum. It having been brought to his attention that suction pumps longer than thirty-two feet from the top of the water in the reservoir to the place of delivery in the pump would not work effectively, he replied to those who asked an explanation of the difficulty, that he could not explain it, only that it seemed in this case nature abhorred a vacuum provided it was not over thirty-two feet long.

Having, however, recommended to his pupil Torricelli the further investigation of this phenomenon, the subject was investigated by him, and the foundation laid of all our positive scientific knowledge concerning hydro-mechanics.

A pump of this simple description is called a lifting pump, and is generally used in houses for domestic purposes. The supply of water thus gained is not, however, sufficiently large for industrial purposes. Besides, it is intermittent; one half of the time spent in working the pump, while the plunger is being forced downwards, there being no flow of water. To remedy this, sometimes double-acting pumps are used, in which one piston ascends while the other is forced downwards.

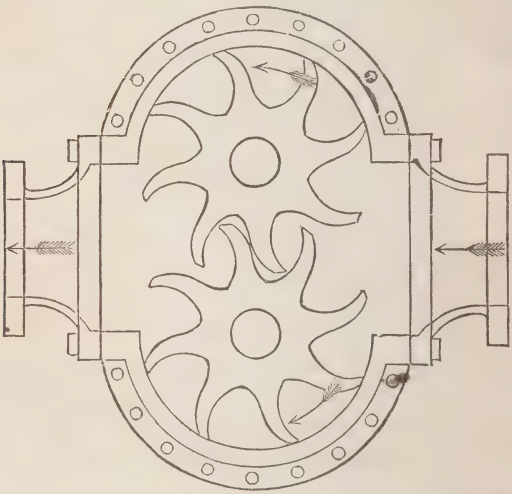
To obtain a still more continuous flow, and also to raise water higher than it can be sustained by the pressure of the atmosphere, force pumps are used. In these the plunger has no valve, and works in a chamber through which the water does not pass, but as the piston is raised, passes in below, and, by the return stroke, is forced through a valve opening outside, and is then conducted wherever desired. By a double-acting force pump, provided with an air chamber, a perfectly continuous flow of the water is secured.

Pumps of this character are objectionable from the complication of their parts and the use of so many valves, which are liable to get out of order. Yet they are still used, and in many cases with great effect. There are instances in which pumps of this character are used in mines, and raise water, at a single lift, to a height of five hundred feet.

The rotary pump is, however, the mechanical arrangement which secures the effective production of the largest amount of work with the expenditure of the least amount of force. It is

impossible to say when the idea of a rotary pump was first introduced, but the manifest superiority of this method has led to its very general acceptance, and also to many ingenious inventions for its practical application.

Of these the simple and effective rotary pumps manufactured by Fales, Jenks & Sons, of Pawtucket, R. I., have, by their popular acceptance, been proved to be the best in use. The founder of this firm, Mr. David G. Fales, having received a practical education as a machinist, in 1830 formed a copartnership with Mr. Alvin Jenks, under the firm name of Fales & Jenks, and commenced, at Central Falls, R. I., the manufacture of cotton



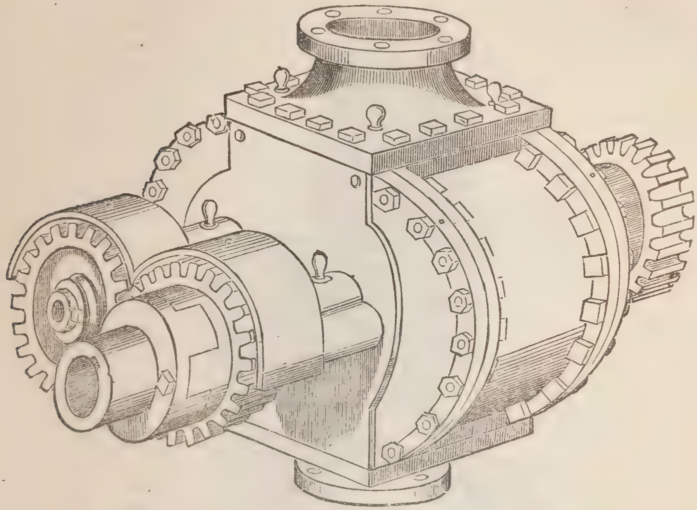
SECTION OF A PUMP.

machinery. The first machine they made was a spooler for a firm in Richmond, Virginia, for which they received sixty dollars.

In 1833 the firm, having purchased the right to manufacture Hubbard's Patent Rotary Pump, have since made it an important article of their manufacture. As will be seen from the accompanying cuts, this simple and effective pump consists of two wheels, enclosed in a cylinder, one driving the other by close-fitting gearing, so as to be water-tight.

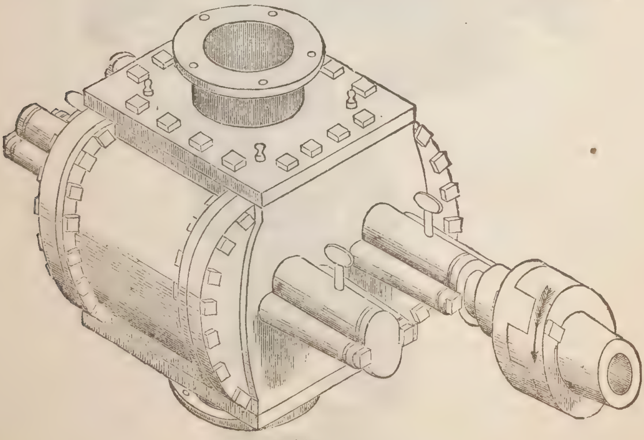
These wheels, revolving in opposite directions, expel the air, which escapes from the enclosing case at the outside of the wheels, thus creating a vacuum, into which the water rushes, and is, in its turn, expelled with great force.

Since the manufactory of these pumps has been in the hands of Messrs. Fales, Jenks & Sons, many improvements have been



GEARED PUMP.

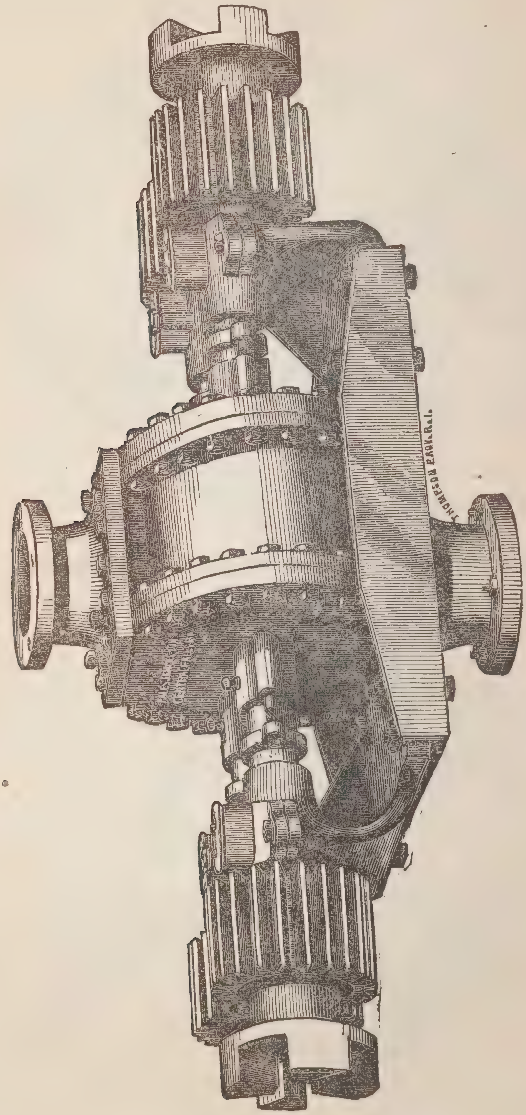
made in their construction, thus greatly increasing their effective working power and their durability, so that they now afford such



ROTARY PUMP.

a security against fire that their introduction into manufactories and other public buildings has created an extensive demand for

them; while the experience of the manufacturers and their facilities have given them almost an exclusive monopoly of their production.



PUMP ON BED, WITH OUTSIDE BEARINGS.

In combination with the manufacture of pumps, Messrs. Fales, Jenks & Sons also make hydrants, both double and single valve,

pipe connections, and everything necessary to completely furnish the water works for a mill or a city. Having recently provided the necessary appliances for the water works of the city of Providence, they have now the patterns needed for making water gates of the largest dimensions, and to contract for the gates, hydrants, and valves needed for the works of cities of any size.

In April, 1854, Alvin F. Jenks and John R. Fales, the sons of the original partners, were taken into the concern and the present business name of the firm was adopted.

In January, 1856, Mr. Alvin Jenks, whose mechanical skill, sound judgment, and integrity of character had aided so much in building up the success of the business, died, and another of his sons, Mr. Stephen A. Jenks, was admitted to the partnership, the name of the firm remaining unchanged.

In 1865 Messrs. Fales, Jenks & Sons removed their business from Central Falls to Pawtucket, about three-quarters of a mile from their old establishment, purchasing about fifty acres of wild land, which they cleared, and erected upon it their present buildings which occupy about eight acres of ground.

Here, with every requisite for conducting their extensive business, with well organized and furnished founderies, machine shops, carpenter shops, fire-proof pattern buildings, blacksmith shops, lumber sheds, annealing furnaces, and so on, they have at hand everything requisite for carrying on their operations in the most effectual and economic manner, and extending even their wide and deserved business reputation.

THREAD MACHINERY.

THE FIRST THREAD. — THE ART OF SPINNING BY HAND. — THE SPINNING-WHEEL.— SPINNING THREAD BY MACHINERY. — HARGREAVES. — ARKWRIGHT. — CROMPTON. — THREAD-MAKING IN THE UNITED STATES. — THE FIRST COTTON THREAD. — THE COMPLEXITY OF THREAD MACHINES. — MESSRS. FALES, JENKS AND SONS.

THE first thread used by mankind was most probably such as we find in use now by the Esquimaux and by the various savage races still in the world, made from the sinews of animals, or from such vegetable fibres as are fit for this purpose. Upon this condition a great step in advance was made, when it was discovered that a thread could be made, of any length or thickness, by twisting together the shorter fibres which are furnished in greater abundance by various plants.

The art of thus spinning thread must have been arrived at very early in the history of the race, since in the remotest historic times we find the process had already been made quite perfect. The Egyptians had carried the art of spinning thread to a high point of perfection, while in India the use of the spinning-wheel was known long before it was introduced into England.

In the hand method of spinning thread a bunch of carded fibre, of cotton, flax, or wool, was held upon a distaff, under the left arm, while with the thumb and fingers of the right hand the thread was twisted to the right size; the only guide for evenness and regularity of texture being the delicacy of touch in the hand of the operator. As the thread was twisted it was wound upon a spindle.

With this simple and seemingly rude process very fine and even thread was often made. Such spinning being mostly in the hands of women, the term *spinster*, which was formerly used as a synonyme for *woman*, shows how generally this occupation was then performed by them.

The use of the spinning wheel, as an improved method of twisting the thread, was introduced into England in the time of Henry VIII. from India, where it had long been in use. By this invention the production of thread was greatly increased; but the industry was chiefly a domestic one, and really a process of hand labor.

The modern application of machinery to spinning thread began in England in 1767 by James Hargreaves's invention of the spinning jenny.

At first this machine was intended to spin eight threads at once. The name of the machine is said to be derived from a corruption of *gin*, which was itself a contraction from *engine*. An improvement upon this machine was made by Richard Arkwright, who introduced the principle of spinning by rollers, which draw out the slivers, or rolls of the carded fibre. As these rollers are in sets of two, each set revolving faster than the last, the roll is extended sometimes four times its original length.

This improvement, and others introduced by Arkwright, enabled him to make a thread even and firm enough to be used in weaving for both the warp and woof. This improvement was so great upon that introduced by Hargreaves, that he is said to have died from mortification at its success. Arkwright, having patented his invention, acquired an enormous fortune from it, and it has been estimated that his machine, enabling one man to do as much as one hundred and thirty could before, has added to the effective productive force of England as much as a population of forty millions of men would have done.

In 1779 Samuel Crompton, of Bolton, England, completed a machine which combined the jenny of Hargreaves and the roller spinning of Arkwright, and was called the *mule jenny*, or, as generally known, the *mule*.

The original machine used from twenty to thirty spindles; but this carried over two thousand, and needed the attention of only a single operative. It was only through these inventions that the enormous spinning industry of the world became possible, and the production of modern times enabled to attain the proportions and the cheapness which place the luxury of clean clothes within the reach even of the very poor.

In the United States thread spinning was an important branch of industry from the earliest times. Here, as in England, it was at first entirely a domestic industry, and the spinning-wheel was

considered an indispensable utensil in every well-furnished household. When, with the disorganization of trade produced by the revolution, the importance of supplying the demand for home consumption became more apparent, this industry was stimulated by premiums voted by many of the local governments, and the societies instituted for the general encouragement of manufactories.

The first sewing thread ever made of cotton was produced in 1794, at Pawtucket, Rhode Island. Previously to this, flax was the material used in this manufacture. The idea of using cotton is said to have been suggested by Mrs. Samuel Slater, who, while spinning some Sea Island cotton, noticed the evenness and beauty of the yarn it made. The manufacture was introduced by her husband, Samuel Slater, who is so well known as the pioneer of the cotton industry of this country.

With the introduction of machine-made thread, the manufacture of the machinery for this industry has kept pace, and become of itself an important industrial interest. One of the chief representative houses engaged in this business is that of Messrs. Fales, Jenks & Sons, of Pawtucket, R. I.

This firm has made more of the machinery used for making thread which has been manufactured in this country than any other single firm; and the perfect organization of their works, with their promptness in taking advantage of every improvement, are an earnest that in the future they will retain the reputation they have so legitimately earned.

In their extensive works at Pawtucket, covering about eight acres, they have every accommodation requisite for their business, and the organization of the various departments necessary in the various operations enables them to combine the best excellence with the greatest economy of manufacture. The business of the firm is not, however, limited to the production of thread machinery, and under the head of Fire Pumps, a condensed history of its origin and progress will be found.

COAL.

COAL IN ENGLAND EIGHT CENTURIES AGO. — THE FIELDS IN THE UNITED STATES. — DISCOVERY OF ANTHRACITE. — FIRST USE OF IT. — PREJUDICE AGAINST IT. — OPENING OF THE MAUNCH CHUNK MINES. — THE REAL BEGINNING OF THE BUSINESS. — BLACK STONE AND STONE COAL. — ANTHRACITE IN RHODE ISLAND AND MASSACHUSETTS. — THE BITUMINOUS BEDS. — THE ANTHRACITE FIELDS. — COAL DEVELOPING INTERNAL IMPROVEMENTS. — CANALS AND RAILWAYS. — THE WEALTH OF STATES. — IMPORTANCE OF COAL. — ITS UNIVERSAL USE. — EXTENT OF THE COAL REGIONS IN THE UNITED STATES. — COAL MINING. — HOW IT IS CARRIED ON. — DIFFERENT KINDS OF MINES. — COAL MINERS AS A CLASS. — COAL MINING COMPANIES. — COMBINATIONS AND HIGH PRICES. — THE BUSINESS A MONOPOLY.

Coal, anthracite or bituminous, is distributed over a considerable portion of the world, and is unquestionably the most valuable of all mineral products, not only for its illuminating, heat, and steam generating properties, but because, without it, the working of other minerals and of metals to any extent would be impracticable. Newcastle coal was known and used as fuel more than eight hundred years ago, and it is believed that the ancient Britons and the Romans in Britain understood the value of the article. To give only a condensed history of coal and coal mining in all times and in all countries would require a large volume; the purpose of the present article is to give, as concisely as is possible, some account of this great industry and source of wealth in the United States.

Anthracite, which exists to some extent in South Wales, in France, in Saxony, and elsewhere in Europe, abounds in the greatest profusion, and in what is presumed to be an inexhaustible supply in Pennsylvania. It is also found in Rhode Island. The existence of anthracite was first made known to the white settlers in Pennsylvania in 1768, and within ten years blacksmiths were using it for fuel in preference to the bituminous coal from Virginia.

Previous to this time the principal source of coal supply was the Chesterfield coal basin of Virginia, which has the oldest worked collieries in the country, though considerable quantities of coal were imported from England to that colony. In 1784 coal mining began in the vicinity of Pittsburg. In 1791 the Maunch Chunk coal discoveries were made, and soon afterwards the Lehigh Coal Mine Company was organized.

It is stated that anthracite was experimented with early in the present century, at Kingston, Massachusetts, in smelting iron. Though this coal had been for some time satisfactorily used by the blacksmiths, gunsmiths, and iron workers of Middle and Western Pennsylvania, a load sent to Philadelphia, in 1806, was considered on trial to be unmanageable. Two years previously it had been used to a limited extent in Philadelphia as fuel; but as a steam generator it was deemed impracticable. There seems for a long time to have been a positive prejudice against anthracite; but the war of 1812, which raised the price of bituminous coal, called renewed attention to the coal of Pennsylvania, and to means of mining and transporting it. The "black stone" began to be used in some iron mills, and in stoves for warming houses. In 1824 the Mauch Chunk mines sent twenty-four tons to Philadelphia, where it was approved by those who used it; but wood was so plentiful that in six years following only three hundred and sixty-five tons of hard coal had been sent to that city. In 1820 the anthracite coal business may be said to have really begun by the shipment of three hundred and twenty-five tons by the Lehigh Coal and Navigation Company to Philadelphia, and in the same year seventy thousand bushels of "stone coal" from Alleghany County, Maryland, reached the same city. Five years later, the Lehigh mines sent to market twenty-eight thousand three hundred and ninety-six tons; the first working of the Schuylkill region in the same year resulted in a product of six thousand five hundred tons; and in this year, 1820, steam was first successfully generated with anthracite in Philadelphia. From that time forward the progress in coal mining was rapid and immense.

Anthracite coal was discovered in Rhode Island in 1768, but the mines were not worked till 1808, and the working was abandoned and renewed several times, none of the mines seeming to be profitable excepting those of Portsmouth. There is an extension of the Rhode Island field in Bristol County, Massachusetts, and it may have been this coal that was first experimented with at Kingston.

The Appalachian bituminous coal field in this country begins in the north of Pennsylvania, extends south, and includes the south-west part of Ohio, the eastern part of Kentucky and Tennessee, and West Virginia, ending with Northern Alabama. Another great field occupies Illinois, part of Indiana, and a small part of the north-west of Kentucky. South-eastern Virginia and Maryland have extensive fields. The same coal is found in the interior of Michigan, Missouri, and in some other states. The great anthracite region is in the north-eastern portion of Pennsylvania, and there are anthracite fields in some parts of Virginia. Anthracite, semi-anthracite, and bituminous beds are found in close proximity in some sections, and generally near, and sometimes under coal are found vast mines of iron ore, a fortunate proximity of the one for the working of the other.

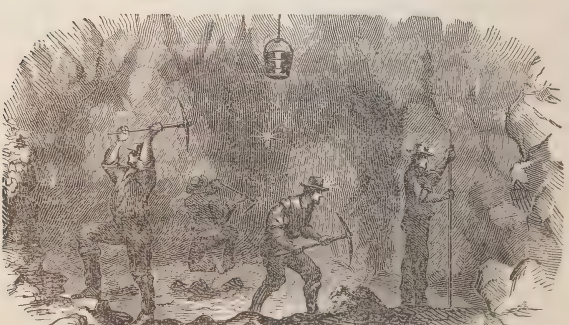
It is interesting to note how the discovery of coal, especially in Pennsylvania, has led to immense internal improvements. In that state no less than nine important canals and twenty-seven railroads have been built expressly for the transportation of coal, and so great is the business that it is estimated that the freights in three years will pay the entire cost of constructing a railroad. Coal has led to the development of enormous wealth in states. The vast iron interest of Pennsylvania owes its importance to anthracite. The manufacturing wealth of such cities as Pittsburg is largely due to the same source. The coal mines of the country have wrought far more prosperity to the people at large than all the gold and silver mined on the Pacific slope. Coal enters largely into every conceivable industry of the country; the bituminous coal not only illuminates cities, but is used as fuel, and extensively in manufacturing; anthracite generates the steam that moves the machinery of the whole country; it warms our houses; and, combined with lignite, is even used in the manufacture of many beautiful and durable articles of use and art. The coal fields of the country cover thousands upon thousands of square miles; they employ millions of capital and thousands of laborers; the demand is equal to all that can be mined; and the supply is inexhaustible.

Coal Mining.

Coal, according to its location, and the lay or dip of the strata, is often worked by quarrying into the side of a hill or mountain; or, when the beds are deep, shafts are sunk, galleries are formed by taking out the coal, and tracks are laid down for the transportation

of the coal from the different parts of the mine to the shafts where it is hoisted. The miners use picks, and huge masses of coal are thrown down by wedges driven into long grooves made in the vein, and sometimes by light charges of powder. Columns of coal are left, and timbers are set up to support the roof. Steam power does the hoisting and lowering, and runs the coal breakers which break the coal brought up from the mines. The coal is separated by screens into "lump," "egg," "broken," "stove," and "pea" sizes. Before it goes to market the slate and stone are supposed to be picked out by boys, who become very expert in the business, though they manage to leave in enough of what is not coal to form the "clinkers" which annoy the consumer.

The coal miners are generally a rough and sometimes troublesome class of men, who are greatly given to combinations and strikes, and who are made responsible for the frequently alleged "scarcity," and consequent high price of coal. On the other hand, it is claimed that the mining companies, by combination, arrange to put up prices, and to charge unreasonable rates for transportation on their own railroads to market. The vast capital required in the business, and the comparatively few great companies engaged, with their power to combine for their own interests, make coal mining a monopoly, and the price of coal far higher than it should be where the supply is so abundant, the fields so near the market, and the means for transportation so easy.



COPPER.

DIFFUSION OF COPPER THROUGHOUT THE WORLD. — COPPER MINES IN THE UNITED STATES. — THEIR RANK IN IMPORTANCE. — FIRST DISCOVERIES IN NEW ENGLAND. — MINES IN NEW JERSEY. — DISCOVERIES IN THE SOUTH. — THE WALLINGFORD AND SIMSBURY MINES. — GRANBY COPPERS. — CONVICTS AS MINERS. — EXPORTS FROM NEW YORK. — THE LAKE SUPERIOR REGION. — GENERAL CASS AND H. R. SCHOOLCRAFT. — CESSION BY THE CHIPPEWAYS. — THE COPPER FEVER. — WILD SPECULATION. — BURSTING OF THE BUBBLE. — SURVEYS BY GOVERNMENT. — DEVELOPMENT OF THE MINES. — COPPER MINING. — HOW IT IS CONDUCTED. — MASS COPPER. — BARREL WORK. — STAMP WORK. — AMOUNT OF PRODUCTION. — COPPER SMELTING. — PRODUCTION OF THE ORE. — LOCATION OF REFINERIES. — USES FOR COPPER. — COPPER COINAGE SUPERSEDED.

Copper, in its native or metallic state, or in combination with other metals and minerals, is generously distributed throughout the world. It is found in profusion in Russia, Norway and Sweden, Great Britain, Prussia, Austria, France, Spain, Italy, Turkey, Algiers, Australia, the East Indies, Japan, South America, Cuba, Jamaica, and Mexico.

The copper mines in the United States rank in importance next to those of gold and iron. Copper was enumerated among the minerals of New England in 1632. In 1648 Governor Endicott discovered copper on his grounds at Salem; he set up smelting works, and imported from Germany and Sweden workmen who knew how to smelt and refine the metal. Before 1660 the copper mines in New Jersey, near New Brunswick, were worked by the Dutch, and at about the same time the mines in the Lake Superior region were known to the French Jesuits. The first settlers in the country noticed that the Indians in many sections had weapons and ornaments made of this metal, and the early colonial reports make mention of copper discoveries in Maryland, Virginia, North Carolina, South Carolina, and very rich mines, affording black oxide and sulphuret of copper, were found in Tennessee.

Early in the last century copper was discovered in Connecticut, at Wallingford and at Simsbury, and in 1709 the oldest mining charter in the country was granted to a company to work the Simsbury (or Granby) mines. These were worked for several years by convicts in the Newgate established there. From 1719 to 1731 the Belleville mine, in New Jersey, produced nearly fourteen hundred tons. In 1732 other mines were discovered in New Jersey and in Pennsylvania. In 1737 the "Granby coppers," used as coin, were stamped in Connecticut, and, as they were pure metal, they were much in demand by goldbeaters for alloy; much of this ore was also exported to Europe. In 1766 eighty tons of copper ore, valued at one hundred pounds a ton, were exported from New York. In 1810 considerable quantities of copper were extracted from pyrites in Vermont and New Jersey. In 1813 the copper workers of Massachusetts petitioned Congress for protective duties on imported copper sheets and bolts. In 1836 a very rich mine was discovered in Bristol, Connecticut, and was worked from 1847 to 1857, when it was abandoned.

The Lake Superior region mines, mentioned above as known to the French Jesuits before 1660, were first worked to a very small extent near the forks of the Ontonagon in 1771. In 1819 General Lewis Cass and Mr. H. R. Schoolcraft visited and reported upon the mass of native copper on the west fork of the Ontonagon. A short time afterwards the United States government ordered a scientific expedition to the region, and a geological survey by the State of Michigan soon followed. The cession of this region by the Chippeways, in 1843, opened the vast and rich mineral region to miners, and in the following year the "copper fever" broke out.

The reports of the discovery of huge masses of native copper, containing silver enough to pay for the working, produced an excitement almost equal to that which prevailed four or five years later when the California gold fever was epidemic. Speculators, geologists, and miners went mad over the Lake Superior copper. Innumerable companies were formed; thousands upon thousands of miners and adventurers emigrated to the region; hundreds of government permits were taken out to select and locate on mining lands; tents and settlements sprang up like mushrooms on the hillsides; and great fortunes were made and lost every week — not at the mines, but in Wall Street. There had been nothing like it since the mulberry tree fever a few years before.

As in all speculations of this character, there was the usual, or an unusual, amount of swindling in selling worthless veins, which appeared and were worked only on paper. During the mania, prominent journals in New York, and elsewhere throughout the North and West, were enlisted, or were interested, in the enterprise, and helped materially to keep up the excitement. In 1847 the speculative bubble burst, and on a thousand tracts of a mile square each not more than half a dozen companies were actually mining — the rest of the tracts were abandoned, and the paper companies exploded.

It was time now to develop the real riches of the region, and Congress passed an act authorizing the survey and sale of the mineral lands in the district. Three years afterwards, in 1850, a geological map of the region was completed; companies with large capital were chartered, and copper mining at Lake Superior began on a firm basis. The mines are grouped in four regions, — at Keweenaw Point, Isle Royale, Ontonagon, and Portage Lake, — and at these points there are several companies, whose business is constantly increasing. The annual product from all the mines is enormous. Much of the product is native metal, not ore, and some silver is found in connection with it.

In mining, the copper is classed as follows: First, mass copper, which is cut out with cold chisels, in lumps of several hundred weight, which yield from seventy to eighty per cent. of pure metal; second, barrel work, consisting of pieces too large to be stamped, and which must be packed in barrels for transportation; and third, stamp work, which is the ore crushed under steam-worked stamps and packed in casks and barrels. Before crushing, the rock containing the copper is "roasted," care being taken to uniformly diffuse the heat to prevent the copper from becoming fused and oxidized. In taking out mass copper, which is done in lumps weighing several tons, months may be occupied in the cuttings before a blast is made. These huge masses are subsequently cut into pieces of more convenient weight and size for shipment.

It is estimated that the production of copper in the world has more than doubled within a quarter of a century, and the increase is largely due to the discoveries at Lake Superior. Notwithstanding this, and the increase of copper works in the country, the United States still imports Cuban and Chilian ores, pig and bar copper from South America, and sheathing copper from Great Britain.

The reduction of copper ore requires that the work should be carried on where fuel is plentiful and cheap, and consequently copper smelting is seldom conducted at the mines. Thus, at one time, half the copper in the world, including the rich product of the Cornwall and Devon mines, was smelted at Swansea, in South Wales. In the United States the smelting works for imported copper are generally situated on the Atlantic coast — at Boston, New Haven, New York, New Jersey, and Baltimore ; and some of the Lake Superior copper is melted and refined at Detroit, Cleveland, and Pittsburg. The process of smelting and refining is different in different establishments in this country and abroad, and, in variously constructed furnaces, anthracite and bituminous coal alike are used. The business requires considerable capital and much skill in mixing ores of different degrees of richness. Certain classes of ores require a series of somewhat complicated processes, though the purity of the native copper in the ore from Lake Superior permits its separation by a single melting in a reverberatory furnace.

The tenacity, softness, and ductility of copper makes it applicable to a vast variety of uses. It comes to market in sheets and plates, which are made into sheathing, large and small stills, condensers, boilers, vacuum pans for sugar works, and innumerable utensils, and rods which furnish bolts and wire. Combined with zinc it makes brass ; combined with tin it becomes bronze, gun metal, and bell metal. For coinage, pure copper in the United States has been superseded by nickel and copper, and in England by bronze.

WOOD ENGRAVING.

THE MOTHER OF THE ART OF PRINTING. — THE CUNIOS. — THE FIRST WOOD ENGRAVINGS. — PLAYING CARDS. — ADVANCE IN THE ART. — THE PROCESS OF WOOD ENGRAVING. — TOOLS AND MATERIAL. — DRAWING THE DESIGN. — CUTTING THE BLOCK. — THE REVERSE OF STEEL AND COPPERPLATE ENGRAVING. — PRINTING FROM THE CUTS. — UNIVERSALITY OF ITS USE. — XYLO-PHOTOGRAPHY.

We have already shown, in the article on Printing, how the cutting of letters and pictures on blocks of wood, and taking impressions therefrom on paper, led to the discovery of the art of printing from movable types. The first known wood engraving in Europe is (traditionally and somewhat doubtfully) traced to a brother and sister of the Cunio family, in Italy, who are said to have executed a series of twelve wood engravings, none of which, however, are extant. The date of these engravings is stated to be the year 1285; but probably playing cards, which are known to have been in use ten years earlier, gave rise to the first demand, and first suggested the cutting of wooden blocks with which to print the cards, which, hitherto, had been laboriously drawn and colored by hand. From this beginning to more elaborate attempts on wood, the steps were natural and easy. The art once discovered, very little more was to be learned, except in the improvement of tools and material and artistic skill.

Box is the wood usually selected for engraving. It is cut in transverse slices, which, when smoothly planed, are of the same height as type, so that the engraving can be "worked in," stereotyped, or electrotyped with a page of type. The wood is thoroughly seasoned, and cut in square or oblong blocks, several of which can be neatly joined together for very large cuts, with the additional advantage that different parts of a design may be simultaneously engraved by different engravers, and afterwards connected, thus enabling illustrated papers, especially, to secure in a

week, or less, and sometimes in a day or two, full-page pictures, on which a single engraver might work for weeks.

In the first wood engravings the design was drawn on the block with a pen and ink ; but now the artist covers the surface with a thin coating of flake white, and carefully draws the design with a lead pencil, using tints to represent sky and water. The block is now ready for the engraver, who, with gravers and gouges of various sizes, proceeds to cut out every part of the wood not covered by the drawing, thus precisely reversing the process of steel and copperplate engraving, and leaving the raised lines to be printed from. The tinted parts of the design the engraver covers with fine lines, which, when printed, will produce the same shade. The greatest nicety is necessary in the entire work, as a single careless slip of the graver may spoil the whole design.

For the effect to be produced by the impression, quite as much depends upon the printer as upon the engraver of the wood cut. The management of light and shade, so that one part of the block shall receive the full pressure, while in another part the paper to be printed is merely touched, is secured by underlays of paper in particular spots, to raise and lower the surface of the block. Very often a printer will spend many hours, and even days, to thus prepare the block for proper printing.

This beautiful art has had its days of decadence, and almost of disuse ; but at the present time it seems to be at the zenith of success, for never before was there such a demand for elaborately finished and costly wood engravings. They are seen everywhere, in the very highest style of the art, in magazines, illustrated papers, and in books even of the most expensive kind. The comparative cheapness and the capabilities of this class of engraving for book illustrations have led largely to its use, and to the proportionate exclusion of steel and copperplate cuts. This is equally observable in the recent publications in Germany, France, Great Britain, and the United States.

As already stated, wood cuts may be, and usually are, electrotyped or stereotyped ; and blocks may be prepared so as to receive a design by the photographic process, and then be at once engraved as if the design had been drawn in the usual method. This art is termed "xylo-photography."

STEEL AND COPPERPLATE ENGRAVING.

ANTIQUITY OF THE ART. — ITS MENTION IN THE BIBLE. — EARLY GREEK ENGRAVERS. — THE CHINESE. — THE FIRST IMPRESSION ON PAPER. — MASSO FINIGUERRA. — THE OLDEST KNOWN COPPERPLATE ENGRAVING. — ALBERT DURER, REMBRANDT, VANDYKE, AND RAPHAEL. — DE LIEGEN AND PRINCE RUPERT. — FURTHER DISCOVERIES. — THE ART IN ENGLAND. — HOGARTH. — COPPERPLATE ENGRAVING. — ETCHING AND FINISHING. — DETAILS OF THE PROCESS. — ENGRAVERS AND PAINTERS. — THE INVENTION OF ENGRAVING ON STEEL. — ITS SUPERIORITY OVER COPPERPLATE. — JACOB PERKINS. — TRANSFERS. — LINE ENGRAVING. — THE PRESS. — PROCESS OF PRINTING. — PROOF ENGRAVINGS. — THE MEZZOTINT. — COLONEL LUDWIG VON SIEGEN. — HOW MEZZOTINTS ARE MADE. — CASPAR LEHMAN. — ENGRAVING ON GLASS. — APPLICATION OF THE ART.

The art of engraving — that is, of cutting characters and figures on stone and metal, in intaglio and bas-relief, dates back to the remotest periods of Egyptian history. The book of *Exodus*, chapter xxxv., mentions among other skilled workmen "the engraver." Other Eastern nations derived the art from the Egyptians. The Greeks, 500 B. C., are said to have engraved maps of the then known portions of the world on brass or metal plates, which, however, were probably not printed from. It is claimed that the Chinese understood the process of engraving, both on wood and metal, and of printing from the blocks and plates, nearly twelve hundred years before the Christian era; and it is supposed by some that from them the art may have found its way to a few other nations, having been brought to Europe by Marco Polo.

In Europe, the first known impression upon paper from an engraving on metal was taken by a native of Florence, Masso Finiguerra, an engraver of gold and silver plate, who wished to take a copy of an engraving, and did so by using an application of oil and soot, thus succeeding in obtaining a successful copy on damp

paper. This was about the year 1450, and it is believed to be the birth of the art in Europe. It was immediately widely practised, and was soon perfected. The oldest copperplate print in existence — a German one — bears the date of 1461; but so rapid was the spread of the art that before the close of the fifteenth century many books were published which were filled with illustrations and maps printed from metal plates. Eminent painters at once gave their attention to an art which promised to perpetuate and disseminate a knowledge of their pictures, some of them taking the graving tool in hand, — prominent among them Albert Durer, Rembrandt, and Vandyke,— while Raphael depended upon Marc Antonio and other Italian engravers for the transfer of his designs.

Almost simultaneously with the discovery of engraving, De Liegen introduced the style called "mezzotinto," which was materially improved upon by Prince Rupert, to whom the style is sometimes attributed. The discovery of etching — that is, where the impression is "bitten in" on the plate by acid — is attributed to both Parmegiano and to Albert Durer. The spread of the art of engraving was rapid, and it was known in England certainly as early as 1483. The various styles of engraving, as *etching, line, mezzotinto, stipple,* etc., were distinctly defined and extensively practised; but with many eminent engravers, and with the production of great numbers of celebrated and costly engravings, no marked progress was made in the art till the eighteenth century, when Hogarth and others brought it to nearly its present state of perfection. Up to the year 1815 — except a single print in London in 1805 — copper was exclusively used; steel engraving, as now known, was, as will be shown anon, an American invention.

With this brief account of the discovery and early history of the art, we proceed to describe its present practice.

Copperplate Engraving.

The tools of the engraver are the "etching point," or needle — a steel wire inserted in a handle, and sharpened to a point, and of which he has two or three sizes; the "dry point," a needle used for the finer lines; the "burin," or graver, of which he has several, the points of which grade from lozenge shape to square; a "scraper" for taking off the "burr" raised by the needles on the plate; the "burnisher," to soften lines which are too dark, to remove scratches, etc.; and the "dabber," which is a silk bag enclosing a little tightly-packed cotton, and is used to spread the etching-

ground evenly. He also has between the light and the plate a "blind" of tissue paper stretched on a frame to enable him to see his work more clearly.

The simplest form of copperplate engraving is to cover the surface of the plate with an evenly-spread, thin coating of white wax, upon which a transfer is taken by pressure of the design drawn with black pencils upon paper. With the needle, the transfer is traced through the wax on the copper, the wax is melted off, and the picture is completed by the proper gravers. The burin is pushed forward from the engraver; but in making the more delicate lines, the needle or dry point is used as if it were a pencil. All the instruments require frequent sharpening on a hone, and the cleanliness and polish of the plate are preserved by repeated rubbings with a woollen cloth and sweet oil. The parallel lines, for sky, water, shading, etc., are cut by ruling machines. Dot engraving, or "stippling," to produce shading, is done with a graver turned down to make dots or punctures only.

But this simple process is improved upon by what is called "etching," which is now the usual method of engraving upon copper, steel, or glass. This is a chemical process. The plate is first covered with the etching-ground, consisting generally of equal parts of black pitch, white wax, asphaltum, gum mastic, and one-fourth of a part of Burgundy pitch spread evenly over the plate with the dabber. This surface is then smoked over candles till it is evenly covered with lampblack. The outline of the design to be engraved, drawn with black lead pencil on paper, is then transferred to the lampblack by means of a press. The points or needles are now used to follow the lines of the transferred design, and to remove the ground for the action of the acid, care being taken to use finer or coarser instruments to produce the effect of skies, distances, and foreground.

The plate is then bordered, half an inch high all round, with "banking-wax," composed of Burgundy pitch, beeswax, and sweet oil, and is ready for the process of biting in. This is done with nitric acid diluted with four or five parts of water, to which a very little sal ammoniac is added. The etching-ground resists the acid, which corrodes or bites into the parts of the plate exposed by the needles. When the lighter shades are sufficiently bitten in, the acid is turned off, the plate is washed and dried, and the finished portions are covered with Brunswick black — a mixture of lampblack and turpentine. The plate is again subjected to the acid for

deeper biting in for the next darker shades, which, after twenty minutes or half an hour, are in turn covered or "stopped out," when a third or fourth biting in follows, with successive stoppings out, till the requisite depths are secured for the different shades. The process of "re-biting" may be performed at any time, or any part requiring it, by stopping out the other portions of the plate.

The border is then taken off, and the etching-ground, after heating, is readily removed by means of a cloth and sweet oil. The engraver with his instruments now goes over the plate and finishes it, or he puts in those parts which were intended to be done wholly by the graver after the principal portion of the plate had been etched. Further shading is sometimes made on the etching by stippling. From this description of the common process of engraving it will be seen that the engraver, in order to produce the proper effect of light, shade, and distance, must himself be an artist, or at least a first-class draughtsman. Indeed, some of our best artists — notably A. B. Durand, of New York — have been equally eminent as engravers and painters.

Engraving on Steel.

As has already been stated, engraving on steel is an American invention, due to Jacob Perkins, of Newburyport, Mass., but who went in 1814 to Philadelphia, where he associated himself with an established engraving firm for the purpose of perfecting his machinery. The processes for engraving on steel and copper are nearly similar; but in etching on steel, on account of its liability to rust, and its extreme hardness, the mixture for biting in is composed of equal parts of nitric acid and pyroligneous acid with three parts of water, and is not permitted to remain on the plate more than a minute, when it is washed off. The etching completed, the plate is finished with tools as in copperplate engraving.

The superiority of steel plates over copper plates is not alone in their greater hardness and durability, and consequently in the far greater number of impressions that can be taken before the plate is worn and needs re-touching, but chiefly in the facilities they afford for duplication. And herein is the great merit of Mr. Perkins's invention. Thus, when the finished plate has been hardened, an impression may be taken in relief on another steel plate, which in turn is hardened, and may then be used to reproduce, by pow-

erful pressure, any number of copies of the original plate on other softer plates, which, when hardened, are used in printing the engravings.

"Line engraving," in which the plate, after etching, is entirely finished in lines made by the graver and dry point, stands at the head of the art, and well-known pictures of this class have made the fame of the engraver nearly as great as that of the painter of the picture. Many engravings, however, present a combination of line and stipple (dotting) which is very effective.

For steel and copperplate printing a peculiar press is requisite. A steel plate, even when the original only is to be used, is not always hardened, nor, considering the possibility of damage to the plate, is hardening desirable where special delicacy is required; and with careful handling thousands of impressions may be taken from a soft steel plate without material wear. The press consists of two wooden rollers, one above and one beneath the bed on which the plate is laid. The plate is inked with the greatest care for every impression. When it is wiped perfectly clean, so that only the incisions hold the ink, it is put on the press, the paper is laid on, and is covered with one or more folds of blanketing, the plate is passed through the point where the rollers meet, and the impression is made. For proof impressions, which are the first few taken from the plate, and which command, sometimes, extraordinarily high prices, special and skilled workmen are employed, who devote perhaps a day to taking not more than thirty impressions of a fine engraving. The entire process of inking, cleaning, and printing the plate requires such care and attention that the artist is quite as much indebted for the reproduction of his design in engraving to the printer as he is to the engraver.

Steel has nearly, if not entirely, superseded the use of copper for the more important engravings. It is not within the province of this article to give a detailed account of the many processes and experiments connected with engraving, such as depositing a steel surface by means of the galvanic battery on a copper plate, the efforts to etch plates (especially for outline maps, coast survey plates, etc.) by the daguerrotype process, and other inventions which are, as yet, experimental, or not wholly successful. The object has been to describe the general method of engraving and printing from metal plates.

Other Kinds of Engraving.

The mezzotinto engraving dates back to 1640, and the invention is attributed to Colonel Ludwig von Siegen, of Hesse. This and the similar style called "aquatinta" (now rarely used) have always been popular with certain classes of purchasers on account of the comparative cheapness of the impressions, and from their supposed resemblance to fine India ink drawings. The process of mezzotint engraving is as follows: When the outline of the design has been etched — or without the preliminary etching — the "ground" is laid in by covering the entire face of the plate (steel or copper) with finely crossed lines, which are made by hand with a toothed instrument called a "cradle," or more commonly by ruling machines made for the purpose. The ground thus prepared, if printed from, would give a uniform and nearly black impression; but the engraver proceeds to evolve his design by scraping and burnishing out the ground for the highest lights and the succeeding lighter parts, leaving the untouched ground for the deepest shades. As compared with line and stipple engraving, mezzotint holds a quite inferior grade in the art.

Engraving on glass may fairly claim a place among the "arts." Caspar Lehman, of Prague, is credited with introducing the invention in 1608; but the art of at least scratching initials and legends must have been practised as early as people became possessed of glass and diamonds. Rost, Schwanhard, and other old artists who were famous for ornamenting glass goblets and vessels, used the diamond in making their designs. This engraving is now done by nearly the same process as that already described of etching on copper and steel. The ground is made by a thin coating of wax, the design is drawn through as in etching with the needle, and the biting in or engraving is produced by hydrofluoric acid, which for the deep lines is directly applied, while for the more delicate work the vapor is sufficient. The operation requires four or five hours, and the glass is then cleaned with oil of turpentine. This style is applicable to uses ranging from the mere marking of the apothecary's measuring glasses and bottles to the engraving of initials, names, monograms, arms, and the most elaborate designs on every article of glass for the table or toilet.

SCALES.

THE FIRST METHOD USED FOR WEIGHING. — THE STEELYARD. — THE LAW OF THE LEVER. — A STANDARD OF WEIGHT. — THE MODERN SCIENTIFIC ONE. — THE DELICACY OF MODERN SCALES. — THE APPLIANCES FOR WEIGHING VERY HEAVY MASSES. — PLATFORM SCALES. — THEIR IMPROVEMENT IN MODERN TIMES. — MODERN METHODS COMPARED WITH THOSE OF ANTIQUITY. — THE SCIENTIFIC ERA. — ITS SOCIAL RESULTS IN THE FUTURE.

THE necessity for some method of weighing things must have occurred quite early to mankind. In fact, some writers have proposed to ascribe to man a sixth sense, that of weight, and unquestionably the first method which men most probably used for comparing the weight of two substances was the simple one of balancing them, one in each hand. By this method a general idea of the comparative weight of two bodies can be obtained; but anything like accuracy is manifestly impossible. Though by practice, particularly by those who have a natural faculty for such work, weights may be thus tested with really astonishing precision, yet for general use such a rude method must have soon been found quite inadequate, and would soon be replaced by the use of a bar or stick, supported upon a central point. With a simple contrivance of this kind, the basis was laid for the discovery of the steelyard, which, in its various modified forms, is to-day the most generally used contrivance for weighing.

Though, from the earliest historic times, devices for weighing have been in use, yet it is only in quite modern times that an accurate standard for weights has been arrived at, and the accomplishment of this has been one of the most accurate and brilliant results of the best modern science. By experiment it would soon have been found that, by placing the body to be weighed nearer to the fulcrum, it would be balanced by a weight less than itself, and which would be smaller the greater the difference between the distances of the two arms of the bar, measured from the fulcrum.

The law of the lever, which is also that of the steelyard, since this instrument is only a suspended lever, is said to have been discovered by Archimedes, though before his time, and among the Egyptians, this instrument was in use. If they had not arrived at such a scientific knowledge of the lever as to be able to formulate the law which governs it, they must have tested their balances by experiment.

Though the ancients understood and applied practically many of the laws of mechanics, Archimedes, as we have seen, having demonstrated the law of the lever, yet it was not until the time of Galileo, in the seventeenth century, that anything like a scientific character was given to the study of mechanics; and it was to this philosopher and his successors that we owe the foundation for our present positive knowledge, and positive methods for investigating the laws of force and motion. So far have these been carried in the two centuries since the time of Galileo, that mankind have, in this short period, extended their ability to investigate accurately the phenomena of nature a thousand times more than was done in the thousands of years which preceded the inauguration of this new era of scientific research.

Scales have been constructed in modern times which were sensibly affected by one seven millionth of their load, and it is not uncommon to have them so delicate that they may be affected by the warmth of the body, its approach causing one of the arms to be elongated sufficiently by the heat to affect their balance. Nor is this the most delicate of the instruments used by science. The tension balance, invented by Coulomb, in which the minutest forces of electricity are measured, is still more delicately accurate, while, on the other hand, the astronomers, by the application of the same methods of investigation, have accurately weighed the earth itself, together with the sun, and the other bodies of our solar system.

Platform scales were in use in England before 1796, and in that year a patent for their improvement was granted to a Mr. Salmon. With the introduction of railroads, the use of scales for weighing heavy burdens became necessary, and the accuracy with which these are constructed is shown by a test made in the New York Crystal Palace, where a load of fifty-two thousand six hundred pounds was weighed successively upon every portion of a railway platform scale, the greatest variation from the mean weight being only three pounds. Until about 1830, the appliances for weighing heavy loads, as of hay upon the trucks, throughout the United

States, were such as did not attain any great accuracy; but with the introduction of the improved methods of construction, in which, by an arrangement of levers, the weight is divided so as to bring only a part of it — often as little as a thousandth part — upon the scale lever great accuracy is attained.

When we consider the thousand necessities which daily arise in the transactions of commerce and the duties of domestic life, for accuracy in measuring commodities by weight, the importance of having a means of doing this, which shall be at once correct, simple, and cheap enough to enter easily into general use, becomes plainly apparent. The aid which modern science has lent to industry is nowhere more satisfactorily shown than in the improved scales of all kinds which the new methods of manufacture have furnished for the public. At the same time, also, the difference which exists between modern society and that of ancient times, is shown most plainly in the more general habits of accuracy which are introduced into modern life, as compared to that of antiquity, by the ability to measure and to weigh correctly. It is the application of this method which makes the difference between the science of the present compared with that which was called science in the past. No department of the knowledge gained by experience and experiment can become scientific until its results have been so accurately tested by measure and by weight as to be expressible in figures; and it is really to our ability to thus measure and weigh that our modern progress is due.

The chemistry, too, of the modern world owes its scientific character also entirely to the advance made by mankind in their ability to weigh and measure accurately, and the atomic theory of equivalent proportions, to which the scientific character of chemistry is due, is one of the most brilliant and useful results obtained by the knowledge of modern times. The vague conjecture and experiment of the old alchemists has been replaced by the accurate knowledge of the chemists, and the processes of industry can be carried on with the definiteness of scientific precision, instead of a reliance upon chance. It is by an extension of these methods that all the interests of life are to be raised to the plane of scientific social organization, and the career of mankind be made for each of us, not the sport of chance, but a preparation for the attainment of the best conditions for integral development, with the accompanying happiness which results only from the performance of our functions.

WHITE LEAD AND PAINTS.

.TS IN PAST TIMES. — OIL COLORS.— SUBSTANCES FROM WHICH THEY ARE DERIVED. — HOUSE PAINTS. — PREJUDICES OF THE COLONISTS. — A CLERGYMAN CALLED TO ACCOUNT. — THE OLD BROWN HOUSES OF NEW ENGLAND. — INTRODUCTION OF PAINTS AFTER THE REVOLUTION. — FIRST WHITE LEAD FACTORY IN THE UNITED STATES. — RED LEAD. — COLOR FACTORIES IN PHILADELPHIA. — MINERAL PAINTS. — PAINT MILLS. — PROCESSES OF MAKING WHITE LEAD. — WHITE ZINC. — ITS CLAIMED SUPERIORITY. — EXTENT OF THE MANUFACTURE IN THIS COUNTRY.

The rudest nations have known, from the remotest times, how to prepare paints and dies from various vegetable and mineral substances. Some of the ancients understood the art of making vitrifiable pigments, as is evidenced in the enamelled tiles, more than four thousand years old, brought by Layard from Nineveh. The Hebrew records make frequent mention of the many and brilliant colors used in the adornment of temples and other buildings. The North American savages covered their bodies with coarser, but scarcely more conspicuous paints, than some of our modern belles put on their faces, and used brilliant dyes for feathers, skins, and wampum.

Paints in general include the coarse and fine paints used in ship and house painting, and for interior decorations; artists' colors, which are oil colors prepared with greater care; and water colors, which are mixed with gum instead of oil, are dried in cakes, and when used are wet with water, and are rubbed on a porcelain pallet. For artists' colors, the whites, known as flake white, silver white, Venice white, etc., are prepared from ceruse, or carbonate of the oxide of lead, or from zinc white, or from ceruse and sulphate of barytes. Oxides of iron and different mineral substances furnish yellows. Vegetable substances, oxides, and mercury supply reds. For blues, ultramarine, artificial or prepared from lapis

lazuli, and cobalt are used. Oxide of chromium, *terre verte*, and different salts of copper give greens. Browns are prepared from vegetable substances, from earth and mineral browns in the natural state or burnt, from burnt Prussian blue, from burnt bones, and from the mixture of some vegetable and animal matters. The blacks are from lampblack, which is procured by burning oils and other organic substances in close rooms or vessels, and collecting the carbonaceous deposit, from calcined bones, and from the mineral peroxide of manganese. Various shades are produced by skilful mixing, and the principal requisite for perfect paints is thorough grinding.

For all house paints, or paints used to cover and protect iron and woodwork, for ship and sign painting, and for the various mechanical and ornamental purposes to which paint is applied, white lead or white zinc is the basis. For colored paints a small proportion of the required pigment is added, and the whole is ground with linseed oil in a mill. The paints are prepared of different degrees of thinness for different coats, the first and second coats being the thinnest, and the fourth, or final coat, the thickest, if so many coats are applied. Boiled oil, litharge, sugar of lead, and spirits of turpentine are added to the different mixtures to act as dryers. Pure white lead, or white zinc, presents in the finishing coat a beautiful glazed surface, as if it had been varnished. In graining and wood imitation a yellow or brown coat is first laid on in oil, while the colors to imitate the wood are ground in water, and the grain is made by brushes and tooth combs, the work being finished and brought out by varnish.

The colonists in America were not particularly partial to paint, as the numerous old brown, weather-stained wooden buildings still standing in New England and elsewhere in the country show. In addition to the cost and scarcity of paints, the early settlers had a puritanical prejudice against this kind of adornment; and it is upon record that a Charlestown clergyman, in 1639, was arraigned for exhibiting paint in his dwelling. The first meeting-houses were entirely guiltless of paint outside and inside, and the natural pine took on color only from dirt and age. Indeed, before the Revolution paint on or in houses was very rare, and the few painted houses were evidences of unusual luxury and wealth. When people began to discover that paint was useful in preserving woodwork, as well as making it more ornamental, the pigment generally used on the houses and barns in the rural regions was a coarse

red mixture, and the meeting-houses and the residences of the richest men alone showed the white paint and green blinds, which afterwards became epidemic in New England, and generally throughout the United States, till a better and more prevailing taste substituted tints and shades, which harmonize better with scenery and surroundings, are more agreeable to the eye, and are in the end cheaper, since they require less frequent renewal.

After the Revolution the use of paint in this country became common; but for a long time the greater part of the best paints and all the white lead were imported. In the latter part of the last century the first white lead manufactory in the United States was established in Philadelphia, and some attention began to be paid to making painters' colors from fossils and earths in different parts of the country. In 1811 the manufacture of white lead was considerable, and manufacturers in Philadelphia were making paints of twenty-two different colors, as bright and durable as imported paints, while at Pittsburg, in the same state, there were three red lead manufactories. Four or five years later there were three white lead factories west of the Alleghanies, which claimed to make a perfectly pure article, free from whiting, and superior to the imported. In 1820 extensive factories in New York made red and white lead, and chrome, and other colors. Other factories in Brooklyn, Buffalo, Albany, Boston, and other cities soon followed, those of Brooklyn and New York being the largest in the country. Within a few years great attention has been paid in the United States to the manufacture of white zinc, and many new paints have been introduced, particularly the pulverized stone or mineral paints, which are claimed to be fire-proof, and are much used in painting roofs of buildings.

Ingeniously constructed mills for paint-grinding have been introduced, which to a great extent obviate the deleterious effects to workmen resulting from grinding white and red lead, and several of the more poisonous colors by hand.

The process of making white lead is as follows: Pure lead is rolled or cast into thin sheets, or, by the more recent method, is cast into "buckles," not more than one-sixth of an inch thick, so as to present as much surface as possible to the action of the acid. The buckles are placed in earthen pots, containing at the bottom vinegar or acetic acid. These pots are placed close together in a bed of spent tan; they are covered over with lead sheets, and over the covers a loose flooring of boards, on which tan is placed as a bed for another layer of lead-filled pots.

Tiers of pots are thus built up, till a stack contains several tons of lead, and the whole pile is covered with tan. The fermentation of the tan generates heat, which evaporates the vinegar, and the vapor circulating through the lead effects the conversion into carbonate. The process is a long one, requiring from eight to twelve weeks for its completion; and consequently the factories have a succession of stacks, so that the process of charging and of removing the white lead or ceruse is constantly in progress.

By the process of conversion the lead gains in weight. The carbonate crust, or white lead, is separated by beating it off on perforated copper shelves, which are set in wooden tanks, and are covered with water. It is then collected from the tanks, and is ground in water to fine powder. The final process is drying, and it is then packed in small casks for market. Numerous inventions have from time to time been introduced to render the processes less dangerous to the health of workmen. White lead is sometimes adulterated with the mineral sulphate of barytes, and is further adulterated with cheaper substances, when colors are mixed with it, and it is sold as paint.

The substitution of white oxide of zinc for white lead was discovered in France nearly eighty years ago, but its high cost prevented its general use for several years. The abundance of zinc in the United States has led to its employment extensively in the manufacture of white zinc, and since 1850 three or four large factories have been established in New Jersey, and two or three in other states. By the American process white zinc is obtained directly from the ore, and the consumption of four tons of ore will produce one ton of oxide.

In this process the ores are reduced to powder, and are mixed with about half their weight of anthracite dust. A charge of this mixture is put into a furnace on a pea coal fire, and in six hours the zinc is driven from the ore. The zinc vapor is carried into an iron receiver, where it is cooled. The oxide is next carried through pipes to flannel bags, through the pores of which the gases escape, leaving the light flocculent oxide, which is transferred to stronger bags, which are compressed under steam-driven rollers to expel the air, leaving the zinc in a dense powder. This is ground with bleached linseed oil in iron mills, and is then packed in kegs for market.

The claimed advantages for the American white zinc over white lead are, that there is less or next to no danger to the health of

workmen making or using it; that it gives a pure, brilliant white, which will not tarnish by contact with sulphurated hydrogen; that it is cheaper and quite as good as white lead for using in mixing with other paints, and that it is more solid and durable than white lead. These qualities have led to its extensive use in the United States, and it is also much used in France. One or two of the larger establishments produce each about three thousand tons per year, and it is largely exported. It is also used to a considerable extent for mixing with what is sold as "pure white lead." The production of white lead in the factories in the United States is from six hundred to six thousand tons a year, according to the extent of the establishment.

BEDS.

THE IMPORTANCE OF A PROPER BED. — THE REQUIREMENTS IN THIS MATTER OF THE PRESENT TIME. — BEDS AMONG THE ROMANS. — BEDS IN EARLY ENGLISH HISTORY. — ERASMUS'S LETTERS ON THE SUBJECT. — QUEEN ELIZABETH'S BED. — MATTRESSES FIRST INTRODUCED. — THE MATERIALS USED FOT THEIR MANUFACTURE. — THE COURSE OF IMPROVEMENT IN BEDS. — FEATHER BEDS. — CURLED HAIR MATTRESSES. — THE WOVEN WIRE MATTRESS. — ITS MERITS. — A MILE AND MORE OF WIRE IN A BED. — TEST OF THEIR DURABILITY. — DESCRIPTION OF THE WOVEN WIRE MATTRESS. — THEIR FREEDOM FROM NOISE. — THEIR HYGIENIC ADVANTAGES. — THEIR DURABILITY. — THE DEMAND FOR THEM.

THE necessity for a place to sleep, by its daily recurrence, has made the bed we use one of the most important subjects for consideration. It is from the rest which our sleeping hours bring us that we obtain the strength for our daily work, and with the nervous excitement, consequent upon the intense activity of our modern life, the hygienic properties of the bed we sleep on has assumed more importance than ever before in the world's history.

During all ages, and from the earliest times, men have displayed their invention in designing beds which should gratify their natural love for comfort, for elegance, and for luxury. In the pre-historic times the dwellers in the caves most probably followed the suggestion given them by the animals which they drove out from their rocky dens, in this early stage of the "struggle for existence," and made their beds of leaves. From this condition to providing skins for the coverings of their couches, was a great advance, and with their increasing ability to dominate their surrounding conditions, and provide the materials for gratifying their natural as well as artificial wants, this step was but the first in a long course of invention and improvement applied to beds.

Nor is this strange, since the invention of a bed which shall be at once soft enough to be easy, and elastic enough to accommodate itself to the outlines of the person, without becoming permanently

fixed in depressions, and at the same time not so soft as to offer so little resistance that to lie upon it is like trying to walk in a quicksand, is, as we shall see, a matter which, even in our own times, with all the industrial appliances, and the more extended knowledge which characterizes this epoch of modern civilization, has been realized only within a few years.

Among the Romans and the Greeks, as well as the other nations of antiquity, such an appliance as a mattress was unknown. They made their beds upon couches of wood, which were covered with skins, furs, woollen, and other stuffs. Their luxury in beds consisted only in using more expensive coverings, replacing a sheep's skin by a tiger's, or substituting for a rough woollen blanket one of finer texture, or a shawl of silk embroidered in gold and silver thread. These improvements, or those consisting in replacing the wooden bench which formed their support with one of bronze, or even of gold or silver, was really only a display of greater wealth, but could not be considered in these days an advance towards securing the advantages of a comfortable, luxurious, and healthy bed.

In the early period of modern history, beds were almost universally, in Europe, nothing but bundles of straw. As late in England as the times of Queen Elizabeth, when no carpets were used, and the floor was strewn with rushes, the beds were hardly anything better, and a wooden bench, or any rude framework which lifted the bed above the floor, was a luxury. Erasmus, in his letters, describes the social condition of the people during the reign of Henry VIII., and was disgusted at the state of the floors. The rushes, he says, were so seldom changed, and became so damp, that the feet were constantly kept wet, and thence colds and consumption were quite common. In the dining-rooms, he speaks of the filth collected on the floor among the rushes; the bits of meat and bones thrown to the dogs, who fought around the guests' legs for them; the beer and wine emptied upon the floor; the slices of bread, used as plates for eating their meat on, and then thrown aside, altogether giving us no very high conception of the neatness and fine breeding of the time.

From Delaroche's fine picture of "The Death of Queen Elizabeth," an accurate idea can be gained of the beds of royalty at this period, and consequently those of the common people can be imagined. By a careful study of the times, and from all the contemporary evidence bearing upon this point, Delaroche was ena-

bled to reproduce the scene with a truthful accuracy of detail. The queen is reposing upon a bed formed by spreading cloths upon the floor. She is covered with richly embroidered spreads of velvet, bordered with golden fringe. The moment chosen is when she is upbraiding the Countess of Nottingham for keeping back the ring Essex had sent to his royal mistress just before his execution. The queen herself is gorgeously attired, as was her constant custom, but the comparison between the brilliant coverings of her bed and its position, one which now would be considered as in the dirt, affords an admirable picture of the partial civilization of the times, with its splendor of display and its want of the simplest decencies of the present.

In a work by Thomas Wright, the well-known student of old English literature and the archæology of English manners and customs, and which treats of these, a full account, illustrated with cuts copied from the pictures in the contemporaneous illuminated manuscripts and other sources, will be found of the character and arrangement of the beds of this period, and the manner in which the people of the time slept.

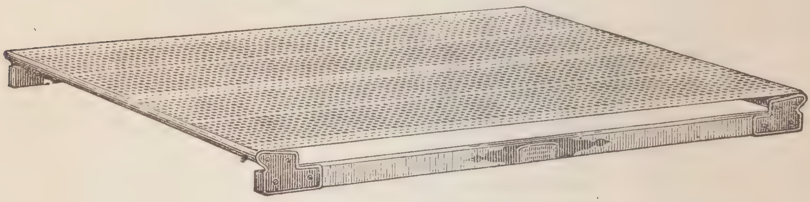
Mattresses were first made of straw or wool, then moss came to be used, and feathers, and finally curled hair. The trouble with all mattresses of these materials is, that they become by use matted and hard, and have to be re-made. Besides, too, all of these materials have a greater or a less tendency to retain the bodily exhalations, and in all public places, such as hotels, hospitals, and other institutions where the beds are used in turn by a number of different persons, the danger of contagion, and the difficulty in any case of keeping the beds hygienically clean and pure, according to the demands of the present medical standard, is very great, if not impossible.

The whole course of modern improvement in beds has been in the direction to obtain the best hygienic conditions of perfect cleanliness and ventilation, combined with the requisite softness and elasticity. The feather bed of seventy years ago, which was then considered perfection, and is still too frequently used, is perhaps the worst possible contrivance for attaining these ends. To lie smothered in feathers, night after night, as must be done with the use of a feather bed, is an outrage against all the laws of health, which is only surpassed by the German method of using two feather beds — one to lie on, and the other for a covering.

The curled hair mattress, made of horse's hair which has been

crimped by machinery, makes a most comfortable bed, having the proper elasticity and spring; but the difficulty with it is the impossibility of properly ventilating it, and its tendency to become matted, thus necessitating its being taken to pieces and re-made from time to time.

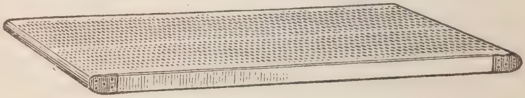
In the woven wire mattress, made by the Woven Wire Mattress Company, of Hartford, Connecticut, an invention has been perfect-



WOVEN WIRE MATTRESS.

ed which secures all the requisites of a bed combining elasticity and softness with a perfect regard for hygienic laws, together with a durability and simplicity of construction which have, in the short time this invention has been before the public, been fully recognized by those who understand and appreciate the comfort and the luxury of a perfect bed.

By ingenious machinery, of the company's own invention, wire, of the requisite size, is twisted into small coils, which are intricately interlocked by a complicated process known as "double weaving." On an average, about eight thousand feet of wire are used in making each bed. The coils are about a half inch in

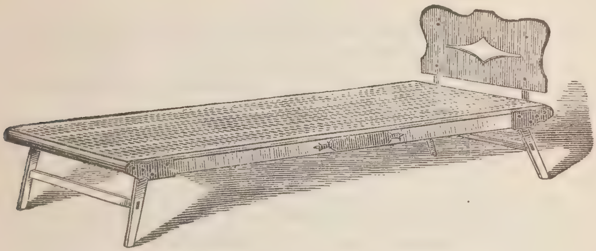


MATTRESSES FOR STEAMER BERTHS, SLEEPING CARS, AND BARRACKS.

diameter, and in a bed of ordinary size some four hundred of these are used. So perfectly are these small coils interlocked that the pressure upon any one of them is diffused over all of them, and thus their elasticity can never be injured, even by the most violent usage. To test this, one of these woven wire mattresses has been subjected for thirty days to a weight of a thousand pounds, consisting of two barrels filled with wire, and at the end

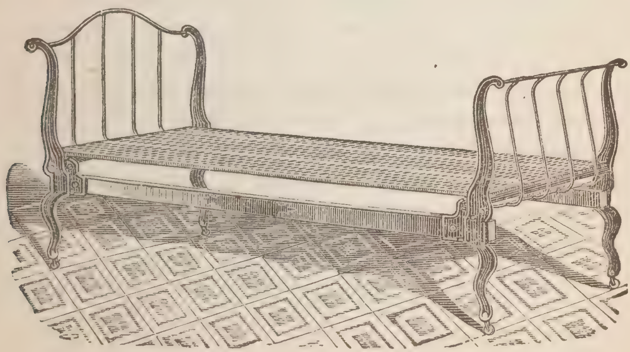
of that time, when the weight was removed, the fabric came back to its place again, as level and as perfect as if the weight had been a single pound instead of a thousand.

This fabric of woven wire is stretched upon a strong frame, and by an ingenious arrangement of screws, which are so simply com-



FOLDING COTS FOR HOTELS AND FAMILIES.

bined that they can be operated by any one of ordinary intelligence, the "tension" of the mattress can be brought to any required point, thus giving an easier, or a harder bed, as desired, making the fabric more or less elastic and springy. By the use of this continuous fabric, the mattress being in one piece, as it were, and supported all round by the frame, the necessity for using slats is avoided, and a perfectly noiseless bed is secured.



DOUBLE COMPLETE BEDS.

The fabric is also so made that it can be rolled up like a piece of cloth, and shipped in small bulk to any part of the country; its attachment to the frame, when necessary, and its disengagement, being a simple matter of a few moments.

The hygienic properties of these woven wire mattresses are perfect. Their metallic nature offers no texture of animal or vegetable fibres to absorb and retain the emanations from the body, while the accuracy with which the frames fit affords no cracks or crevices for the gathering of dust or the harboring of vermin.

The entire bed is open to the free circulation of the air, and can at any moment be thoroughly examined. Besides this, the woven wire mattress unites all the elasticity and firmness of the best combination of the ordinary curled hair mattress with the spring mattress, and at a moderate cost, considering the advantages gained.

With these advantages in its favor, it is no wonder that its use has been adopted by so many hospitals, hotels, steamboats, and public institutions, together with numerous private parties, that, though it has been before the public only three years, yet the company find their production of fifteen hundred beds a month inadequate to supply the demand, and are forced for a second time to increase their arrangements for their manufacture.

The durability of these woven wire mattresses is evident from the material and the method of their construction, yet, to place it beyond question, the company guarantees that they will last five years, and be as perfect at the end of that time as they were at the beginning. Confident as the company is that they will last twenty years, or a lifetime, this guarantee will not probably be extremely dangerous for their pecuniary interests. By the testimonials all over the country, from hospitals and hotels where these woven wire mattresses have been used, it is evident that by this invention the problem which has so long occupied the world of how to obtain a bed which is perfect in every respect, both for comfort and for health, has been solved by the Woven Wire Mattress Company, of Hartford, Conn.

STEAM AND THE STEAM ENGINE.

THE FIRST KNOWLEDGE OF STEAM. — VAPOR NOT STEAM. — THE PRESSURE OF THE ATMOSPHERE. — STEAM AT VARIOUS PRESSURES. — THE HEAT REQUIRED FOR STEAM. — THE POINT FROM WHICH IT IS CALCULATED. — SENSIBLE HEAT AND HEAT OF EVAPORATION. — THE TOTAL HEAT OF STEAM. — BULK OF STEAM COMPARED WITH ITS GASES. — THE STEAM ENGINE. — THE FIRST STEP TOWARDS IT. — DA VINCI'S STEAM GUN. — DELLA PORTA'S STEAM PUMP. — THE MARQUIS OF WORCESTER'S INVENTION. — PAPIN'S STEAM ENGINE. — OTHER INVENTORS. — WATT'S IMPROVEMENTS. — SINGLE-ACTING AND DOUBLE-ACTING ENGINES. — THE COURSE OF MODERN IMPROVEMENTS IN THE STEAM ENGINE. — THE CORLISS ENGINE. — THE RUMFORD MEDAL. — PROFESSOR GRAY'S REMARKS. — MR. CORLISS' IMITATORS IN EUROPE. — THE VAST ESTABLISHMENT OF GEORGE H. CORLISS, AT PROVIDENCE, R. I. — THE LARGEST STEAM ENGINE MANUFACTORY IN THE WORLD. — MR. CORLISS AS A CITIZEN.

The fact that water heated to a boiling point passes off in vapor, must of course have been known from the earliest time that men boiled water in vessels of any kind. But the progress from the knowledge of this fact to the utilization of the energy generated by this process, has been long and arduous; and here as elsewhere we find that the advance has been made step by step, the results gained by observation having in all cases to pass through the theoretical stage before they could be reduced to practical working.

Here too, as elsewhere, the history of this advance shows conclusively how intimately dependent upon each other are all branches of human activity. The scientific advance of this century, by arriving at an accurate knowledge of the nature of things, by its processes of chemical analysis and its use of the various improved methods of observation, has made possible the improvement of practical methods of applying the knowledge thus gained of the laws of nature, while in its turn this practical application has increased the productive force of society, making thus the means of a better and more comfortable life more general.

The vapor given off by boiling water is not, however, speaking strictly, steam. Steam is invisible, and the vapor, even under such circumstances, is steam condensed into vapor, and though it may have steam intermingled with it, yet it is only the vapor which makes it visible. Pure steam is, therefore, always perfectly invisible and perfectly dry. Like all gases, steam possesses the qualities of elasticity and equality of pressure in all directions.

Water, in an open vessel, is kept in a liquid condition by the pressure of the atmosphere, which holds it with a force of 14.7 pounds to the square inch. Heated in such a vessel to 212° Fahrenheit, the expansive force of the heat thus diffused among its particles is sufficient to balance the pressure of the atmosphere, and the water boils, that is, passes off freely into steam.

Steam, therefore, produced in this manner, has a tension or a pressure of one atmosphere, or 14.7 pounds, to the square inch. If therefore a confined vessel is partially filled with water, which is then subjected to heat, it will be necessary to heat the water sufficiently over 212°, or the boiling point in the open air, to overcome the increased pressure of the vapor formed, before it will boil. Thus steam produced at a temperature of 212° is said to have the tension of one atmosphere; at 234°, of $1\frac{1}{2}$; at 250°, of 2; at 274°, of 3; at 292°, of 4; at 306°, of 5; at 340°, of 8; at 357°, of 10; at 516°, of 20 atmospheres, or about 294 pounds to the square inch.

Steam thus produced, in communication with water at the same degree of temperature of itself at the moment of its production, has more or less water or mist mixed with it, and its density is in consequence somewhat affected by this cause. But as a rule, the greatest pressure under which steam can exist as steam, at any given temperature, is the least pressure under which water heated to the same temperature can remain in the form of water.

This pressure is called the pressure of saturation, and steam in this condition is said to be saturated. Steam in this condition stands both at the point of condensation and the point of generation, so that whatever the temperature, the density and the pressure will correspond, and any one of these being known, the others can be readily found. Steam heated independently, and without being in communication with water, will soon lose the moisture it may contain, and is known as superheated steam. In this condition it has all the qualities of a gas.

The heat required to raise one pound of water one degree

Fahrenheit has, by experiment, been found to be represented mechanically by the force required to raise 772 pounds weight through one vertical foot, that is, 772 foot pounds. One pound of water heated to 212°, will occupy a space of 26.36 cubic feet, this being the volume of one pound of saturated steam at the temperature of 212°. If, therefore, a closed vessel of this size is thus filled with steam, and a second pound of water at the temperature of 212° be injected into it, this second pound of water, to become steam, must overcome a pressure of 14.7 pounds to the square inch, before it can find place. To convert the first pound into steam required 892.9 units of heat, and to convert the second pound will require 965.2 units, the 72.3 excess being that which is called for in overcoming the greater resistance which the second pound meets in assuming the condition of steam.

The heat which is consumed in vaporizing a pound of water is thus divided into two parts; the first is called the sensible heat, and consists of the amount of heat required to raise the liquid from some settled point of temperature to the point of vaporation, and second, the amount of heat consumed in converting a pound of water raised to the point of vaporation into vapor, or, as it is called, the latent heat of vaporation. The point selected from which the sensible heat is reckoned is 32°, which, for calculations concerning steam, is considered as zero. The sum of these two quantities, the sensible heat requisite to raise water from 32° to the point of vaporation, and the heat consumed in producing vaporation, is called the total heat of vaporation, or the total heat of steam. The sensible heat is readily arrived at, but ever since the invention of the steam engine it has been an important point to arrive at some method of accurately ascertaining the amount and the variation of the total heat of the steam. Count Rumford estimated the latent heat of one pound of water, at the boiling point, at 1050.5°, the committee of the Franklin Institute of Philadelphia at 1037°, while Regnault, who conducted his experiments with great caution and accuracy, gives the total heat of saturated steam at 212° as 1146°; this being the total consumption if the water is supplied at 32°.

In the works of Tredgold or Bourne upon the steam engine accounts may be found of the methods and apparatus used in these experiments. It must be remembered, however, that the total heat of steam cannot be taken as a measure of its energy, or the force for work which can be practically obtained from steam.

Much of the heat thus absorbed has been consumed in overcoming the cohesive force of the liquid, and at all temperatures it is only a small part of the total heat of steam which can be made practically available. From 32° to 212° all the heat which has been absorbed by the water has effected no change in its physical condition, but when this temperature is reached, steam is produced, and acts under certain fixed laws. A cubic inch of water, thus vaporated under the pressure of the atmosphere, is converted into a cubic foot of steam, which exerts a mechanical force equal to what would raise a ton one foot, and it is safe enough for all practical purposes to estimate that for each cubic inch of water vaporated, at any pressure, an energy is developed equal to raising a ton one foot: As any given rate of vaporation produces a given power, the following rule is applicable to estimating its extent. To produce one horse power, which is a mechanical force equal to 33.000 pounds, or about 15 tons raised one foot, fifteen cubic inches of water must be vaporated, or about 900 cubic inches an hour. If, therefore, to this amount be added the quantity necessary to move the engine itself, independently of the work it has to perform, we shall arrive at the quantity of water which must be supplied to the boiler for each horse power, and this will be the same whatever is the size or proportions or the cylinder.

Water converted into steam at 212°, and under the pressure of one atmosphere, expands into a volume 1.700 times greater than its original bulk. The gases of oxygen and hydrogen of which the steam is composed would occupy 2.500 times the bulk of the water. In practice it is found that the bulk of steam is less than what it should be theoretically, being variously estimated at from 1.670 to 1.642 times the bulk of the water from which it is evolved. Thus the density and pressure of steam always exceeds that which ideal steam would exert, or what it would be were it a perfect gas.

The steam engine, essentially as we have it now, is an invention which is only about one hundred years old. The ancients were aware of some of the mechanical properties of steam, and its expansive force was written of by Hero, or Heron, a philosopher of Alexandria, who lived in the third century before Christ. In his work, entitled *Pneumatica*, or upon pneumatics, which has been frequently printed in modern times, he describes several applications of the mechanical effects of steam. One of these is an ar-

rangement by which a boiler is made to revolve about its vertical axis by jets of steam issuing from holes in the sides of the projecting arms with which it is provided. No use was, however, attempted to be made of this from his time until the invention of printing having rendered his work accessible, attention began to be attracted to this subject.

Among the sketches left by Leonardo da Vinci, who died in 1519, is a drawing of a gun, the projectile force of which is steam. In 1543, it is stated that Blasco de Garay, of Barcelona, propelled a vessel by paddles, worked by "a water boiler, liable to burst," — but the statement is hardly worthy of confidence. In 1601 G. Della Porta, in his *Pneumatics*, described an arrangement for raising water, by a tube, into a vessel in which a vacuum had been made by steam. In 1615 Soloman de Caus, a Frenchman, published a book, entitled *Raisons des Forces Mouvantes*, in which he described a fountain made by the propulsion of water from a tube by the force of steam generated in the vessel. In 1629, Branca, an Italian, described a method of propelling a wheel by the force of steam driven against its vanes. The Marquis of Worcester, in his *Century of Inventions*, published in 1663, gives an involved description of an invention for raising water by steam. The steam was alternately generated in two vessels, and conveyed by pipes, was made to exert a pressure upon water in a third. By means of this contrivance he claims to be able to raise water forty feet, and the vaporized water would raise forty times its bulk of cold water. Cosmo, the Grand Duke of Tuscany, says that in 1656 he saw one of these machines in operation in Vauxhall. Denis Papin, a French inventor and mechanician, who died in Germany about 1710, published in Frankfort, in 1707, a Latin treatise, entitled, *Essay upon a new System for raising Water by the Action of Fire*. Having been forced, as a Protestant, to leave France, he was appointed, in 1687, a professor of mathematics at Marburg, and devoted his attention to the study of steam. In the *Acta Eruditorum*, for 1690, he proposes steam as a motor, and describes a steam engine. In 1852 Professor Kuhlman discovered from documents in the public library at Hanover, that in 1707 Papin had constructed a vessel to be thus propelled, and tried it on the Fulda. He prepared and used a piston in a cylinder, under which a vacuum was produced by the condensation of steam, and also invented the safety valve for boilers.

In 1698 Captain Thomas Savery patented a machine for raising

water by steam, which was much used for draining mines, the water thus obtained being in some instances used for driving other machinery. He used two boilers and two condensers, into which, by means of a vacuum made by condensing steam, he drew the water, and afterwards forced it higher by the pressure of steam. The power for some of the mills in Lancashire was obtained by machines of this kind. In 1705 Savery, in connection with Thomas Newcomen, a smith, and John Cawley, a plumber of Dartmouth, patented an engine in which they had combined a cylinder and piston with a separate boiler. The piston was driven by steam, which was afterwards condensed by the application of cold water to the outside.

By an accidental hole in the cylinder, which admitted the water to the inside, it was found that this method of condensation was much better, and it was adopted. The valves for the admission of the steam were at first operated by hand, and boys were hired for this service. Among the improvers of the steam engine, one of these boys, whose name was Humphrey Potter, should not be forgotten. Being a youth who united an insatiable desire for play with a habit of observation, he soon saw that he could make the engine itself perform the task allotted him, by uniting his valve by a string with another portion of the works, and thus secure for himself full leisure for indulging his playfulness. Though the apparatus he arranged for this purpose was effectual, it was very clumsy, yet it continued in use until 1788, when Henry Beighton constructed an engine in which the valves were worked by a rod connected with the beam.

Of Potter's further history there is no record. The success of his invention had been of great importance to the world, but had evidently destroyed his own occupation, and most probably his talent for invention having thus proved disastrous to himself, was never further displayed.

Various other improvements were made in the working details of the steam engine before James Watt, but it was at his hands that the steam engine received practically its present form. He made it really a scientific application of the energy of steam. Before his day the force had been exerted only in one direction; and in fact the motive power of the engine was rather the pressure of the atmosphere than the expansive force of steam. Besides, as the vacuum beneath the piston was never made perfect, the whole pressure of the atmosphere was never exerted. Up to his

time the machines in use were rather atmospheric than steam engines, and were called "fire engines," being so named by Watt himself in his earlier memoranda.

Having had his attention turned to the theoretical study of steam in the course of his regular business as a mechanician, he first practically applied his mind to the subject on being called upon to repair a model of a Newcomen engine, which was in use to illustrate the lectures of Professor Anderson before the students of the university in Glasgow. In reflecting upon the subject, he soon saw that, to use his own words, "in order to make the best use of the steam, it was necessary, first, that the cylinder should be maintained always as hot as the steam which entered it; and secondly, that when the steam was condensed, the water of which it was composed, and the injection itself, should be cooled down to 100° or lower, where that was possible."

It was in the winter of 1763–4 that the model was brought to him for repair, and in 1765 he had conceived the idea of a separate condenser, as the method for meeting the requirements of the case. "When once," he says, "the idea of the separate condensation was started, all these improvements followed as corollaries in quick succession; so that, in the course of one or two days, the invention was thus far complete in my mind, and I immediately set about an experiment to verify it practically."

The improvements he speaks of were connected with the cylinder. Before his time the piston was packed with water, the cylinder was vertical, and the head was open so as to admit the pressure of the atmosphere. Watt proposed "to put an air-tight cover upon the cylinder, with a hole and stuffing-box for the piston rod to slide through, and to admit steam above the piston to act upon it instead of the atmosphere."

He also provided a "steam jacket" for the cylinder, in order to prevent its cooling. As we have seen, up to this point the various steps of improvement in the steam engine were made by almost as many inventors. The Marquis of Worcester first applied the pressure of steam to practical use. Savery first made use of the vacuum produced by condensation, though he did not discover the best method, nor see the advantage of its application. Papin first used a piston to receive and transmit the force of pressure. Newcomen and Cawley used first the piston and the cylinder independently of the boiler. Potter and Beighton first made the working of the valves automatic, while Watt introduced

the separate condenser, and the various improvements which depend upon its use.

The machine was as yet, however, a "single acting" engine. Only the downward thrust of the piston was used, and steam was introduced below it only for the purpose of returning it to its place. Thus the engine was chiefly used for pumping purposes, and from the irregularity of its motion it could not be applied to a constant rotary action. As early as 1769 Watt had seen that the working of the engine could be improved by using the expansive force of steam for a portion of the stroke of the piston, the supply being cut off before the piston had completed its thrust, and the rest of its stroke being produced by the expansion of the steam already let into the cylinder. In 1776 he built a machine to work upon this principle, and in 1782 patented it, with other improvements.

In 1782 Watt patented an invention of a double-acting steam engine, in which the energy of steam was used in driving the piston both up and down, and which was provided with a throttle valve for the introduction of the steam, and also with a governor and an indicator.

The first engine constructed to work without a condenser, or a high-pressure engine, was made by Oliver Evans, of Philadelphia, in 1787, or as some authorities have it before 1785.

By the course of invention, which has here been only rapidly sketched, the chief principles upon which the steam engine has been made a practical means of utilizing the energy of steam have been developed, and during this century the chief application of inventive genius has been turned in the direction of improvement in the combination of the parts of the engine itself. There has been no fundamental change in the conception of the necessary parts of the steam engine, but various modifications of the mechanism by which the power has been economized, or the necessary friction of the parts been lessened. Influenced by the same spirit which has characterized the scientific advance of this century by the increasing necessity of more accurate methods, and forced by the industrial competition of the age to consider the importance of economy of time and energy, the improvers of the steam engine have seen that their inventions would be recognized as valuable only as they attained the same results with increased simplicity of action, with less waste of power in the working of the mechanism, or with less supply of fuel.

Tredgold, the last edition of whose exhaustive treatise upon the steam engine was published in 1862, and who is recognized as the chief authority upon this subject, says, "the apparatus for opening and closing the passages is of more importance to the perfection of the steam engine than any other part of its mechanism. In the present state of the engine, the action is either very complicated or imperfect."

To examine carefully the various steps which have been made towards the perfection of this most important part of the mechanism of the steam engine would occupy too much space here. We would find, as we have found in the history of the practical application of the energy of steam, that by the projected changes of various kinds the knowledge and experience were slowly gathered which enabled a man, as Watt did, to take a comprehensive view of the whole matter, and seeing what had been done, and what was required to be done, attain the desired end by a strictly scientific combination of the means already known, or by an equally scientific adaptation of entirely new means of his own invention.

As Watt, in the last century, found the steam engine an imperfect and wasteful arrangement for utilizing only a small portion of the energy of the steam supplied to it, and by the invention of a separate condenser, and then by his method of making the engine double acting, made it really a steam engine, so in this century the credit belongs to George H. Corliss, of Providence, R. I., for improvements by which, in the engine known under his name, simplicity of construction, together with perfection in economy of working, have been secured. The improvements which Mr. Corliss has made in the mechanism of the steam engine have been recognized by the American Academy of Arts and Sciences, and publicly acknowledged by this body in presenting him with the Rumford Medals.

In 1796 Count Rumford placed in the hands of this society a fund, the income of which should be used to provide two medals, one of gold and the other of silver, together of the intrinsic value of three hundred dollars, which should, according to the judgment of the society, be awarded, from time to time, "to the author of any important discovery or useful improvement on light or on heat, which shall have been made and published by printing, or in any way made known to the public, in any part of America, or of any of the American islands, preference being always given

to such discoveries as shall, in the opinion of the Academy, tend most to promote the good of mankind."

The first award of these medals was made by the Academy to Count Rumford himself, for his experiments, by which he laid the foundation, and inaugurated the method of investigation, which since his day, in the hands of his successors, have led to the most brilliant and valuable generalization of modern science, that of the correlation and persistence of force.

In the century during which this fund has been in existence, the Academy has found occasion to make only five awards of these medals, — a fact which shows the careful and judicious investigation they have made in examining the claims of inventions to receive this recognition and honor.

The Academy having voted these medals to Mr. Corliss for his improvements in the steam engine, they were presented to him in January, 1870. The following extracts from the address made upon the occasion by Dr. Asa Gray, the President of the Academy, will show the reasons upon which the Academy based their award. After speaking of the foundation of the trust, and of the considerations which actuate the Academy in the bestowal of the medals, Dr. Gray continued : —

"It would not hesitate to crown any successful, however recondite or theoretical investigation within the assigned domain, being confident that no considerable increase of our knowledge of the laws and forces of nature is likely to remain unfruitful. But the Academy rejoices when, as now, it can signalize an invention which unequivocally tends to promote that which the founder had most at heart, and commended to our particular regard, — the material good of mankind.

"Without entering into details, it will be possible to state the ground upon which the present award has been made. It is for the abolition of the throttle valve of the steam engine, and the transference of the regulation by the governor to a system of induction valves of your own invention, with the advantage of a large saving in fuel, and what is more important in manufacturing industry, the maintenance of perfectly uniform motion under varying work.

"Previous to your improvements, the regulation of the power and velocity of the steam engine was universally effected by an instrument placed in the steam pipe, well named the throttle valve, being used to choke off the steam in its passage from the

boiler to reduce more or less its pressure before it was allowed to act within the engine. Avoiding this wasteful process, your engine embodies within itself a principle by which it appropriates the full, direct, and expansive force of the steam, and measures out for itself at each stroke, with the utmost precision, the exact quantity necessary to maintain the power required.

"In the most approved engines previously used for manufacturing purposes, the valves employed were comparatively difficult to operate, too far from the piston, and in other respects unfit for working in connection with the governor. Their abandonment, and the substitution of others suitable for the purpose that you had in view, demanded an entire change in the structure of the engine.

"In the reconstruction, your mastery of the resources of mechanism is conspicuously shown. You introduced four valves to the cylinder, two for the induction and two for the eduction of the steam; and by your device of a wrist-plate, you give to each valve a rapid motion in opening and closing, and a slow motion after the closing has been effected, thus securing a perfection in valve movements never before attained. The special object of these changes, and the *gist* of your invention, was to place the induction valves under the control of the governor, by which they are operated in opening through a mechanism from which they are released earlier or later in the stroke of the piston, according as more or less power is demanded of the engine, — the governor, with extreme sensibility, determining the point when the supply of steam should be cut off." . . .

"Allow me to read to the Academy a brief account of the Corliss engine, by one of the most eminent of British engineers, Mr. J. Scott Russell, which must needs be free from personal or national prepossession. It is from the official report on the Paris Universal Exposition of 1867."

It is proper that we remark that Dr. Gray here quotes from the Report to the British Parliament of Mr. Russell, who was specially delegated by the government of Great Britain as Commissioner to the Paris Exposition. Mr. Russell is a most eminent English engineer, and was the builder of the Great Eastern steamship. The highest *competitive* honor was at the Exposition unanimously accorded by the international jury to the Corliss engine over more than one hundred competing engines, the *chefs d'œuvre* of engine-builders in all portions of the civilized world.

" ' A third remarkable engine is American, both in invention and execution, and forms, perhaps, the most remarkakle feature of the American department. It exhibits thoughtful design, ingenious contrivance, refined skill, and admirable execution. It is singularly unlike an English engine. It has four ports, on four different parts of the cylinder, two on one side and two on the opposite, each worked by a separate mechanism. These ports are worked by valves, not sliding, like our own, on flat surfaces, but sliding valves on cylindrical surfaces. Close up to the cylinder these valves cut off the steam with scarce a particle of waste room, and so economize to the utmost the high pressure steam which they admit, and which they use as expansively and as sparingly as possible. The mechanism by which these valves are moved is, to our eyes, outlandish and extraordinary, but it is, in truth, refined, elegant, most effectual, and judicious; it spares steam to the utmost, but develops what it uses to most effect. Then it proportions, in an admirable way, the dose of steam it serves out to the continually varying quantity of work the engine has to do: The mechanism of its mechanical governor is wonderfully delicate and direct; the governor is sensitive to the most delicate changes of speed, and feels the slightest demand upon the engine for more or less work and steady speed. A mechanism as beautiful as the human hand releases or retains its grasp of the feeding-valve, and gives a greater or less dose of steam in nice proportion to each varying want. The American engine of Corliss everywhere tells of wise forethought, judicious proportion, sound execution, and exquisite contrivance.' "

After noticing the economy of fuel which the Corliss engine makes possible, compared with the older forms, amounting, for the same effective power, to an average of one-third of the fuel, and to its chief excellency, uniformity of velocity, though within the space of a minute, the power demanded by the work should vary from sixty to three hundred and sixty horse power, Dr. Gray continues:

"It is a great thing to say, but I may not withhold the statement, that, in the opinion of those who have officially investigated the matter, no one invention since Watt's time has so enhanced the efficiency of the steam engine as this for which the Rumford medals are now presented."

In connection with the record of the presentation of these medals to Mr. Corliss, it is fitting that we add his reply, not only

as a matter of the history of the occasion, but as a pleasing illustration of the harmony which may exist between the highest order of mechanical and inventive genius and delicate literary taste. It is no small compliment to the democratic spirit of the age, in America especially, that practical life, with all its details of hard and severe labor, is not necessarily divorced from the æsthetical. Mr. Corliss' reply is at once terse, chaste, and logical.

"Mr. President: Competitive honors are the reward of effort, stimulated by rivalry and ambition. *This* honor comes from gentlemen who scan the whole field of science and art, and in deliberate council make their awards in the discharge of a sacred trust. To this consideration I add the historic associations connected with the American Academy of Arts and Sciences, and the scientific fame of its members; and I receive this testimonial with grateful acknowledgment of a distinguished honor."

The United States Commissioners to the Paris Universal Exposition, 1867, in their report to the government (pages 54, 55, and 59 of vol. 4, of said report), say, "The Corliss Steam Engine Company, of Providence, R. I., have sent a thirty horse power horizontal engine, finished with all the mechanical refinement for which their works are justly celebrated;" and after a description of the special points of superiority of this machine over others, add, "In a comparison of the different classes exhibited, it is significant to observe how minutely its features have been copied by noted builders of other nations, as indicative of the esteem with which they regard its novelties. The three most notable copies of the Corliss engine principle are by Messrs. Hick, Hargraves & Co., of Bolton, England; Messrs. Gebrüder Sulzer, of Winterthur, Switzerland, and A. Duvergier, Lyons, France." Surely, the compliment of being thus copied by these eminent foreign builders ought to be sufficiently satisfactory to the pride of the great American inventor; but what should be more satisfactory to his pride, as it is in itself complimentary to the high honor of a great manufacturer himself, is, that Mr. Vandenkerchove, of Ghent, Belgium, one of the most successful engine manufacturers in Europe, is now building steam engines strictly after the Corliss pattern, from designs obtained from Mr. Corliss himself, and paying therefor a valuable royalty.

As illustrative of the delicate and profound recognition which genius sometimes commands of appreciative talent, it is pleasant to note here that Mr. Vandenkerchove went to the Paris Exposi-

tion, taking with him a steam engine of one hundred and fifty horse power of the highest finish, and considered a masterpiece of mechanical execution; his friends confidently believing, with himself, that its merits must achieve the crowning honors of the Exhibition; but, on encountering the Corliss engine, and acquainting himself with its principles, heretofore unknown to him, he withdrew from the contest, bearing away with him the costly descriptive folio volumes which he had prepared to set forth the merits of his own work, — acknowledging himself vanquished, and immediately seeking drawings and plans of Mr. Corliss, and returning home and devoting his well-appointed establishment to the exclusive manufacture of the Corliss engine. He has built a large number of engines for the principal manufactories of Europe after the Corliss pattern, some of which are of seven hundred horse power. The most important machine works of Europe are now following the lead of Mr. Vandenkerchove in the manufacture of the Corliss engine.

The manufactory of the "Corliss Steam Engine Company" merits special notice in a work like this, in which are remarked not only the actual physical achievements of genius and industry, but the æsthetic and moral influences which the pursuit of sundry arts effects. In this establishment and its surroundings we find combined the most effective forces with the highest regard to artistic effects. The site of the works comprises something over nine acres of land, substantially enclosed. In a strictly financial point of view, the attention to neatness and order observable here cannot but prove to be an excellent investment, from which manufacturers throughout the land might well draw a sensible suggestion. Pleasant surroundings serve to evoke the interest of the employee in the establishment to which he is attached, and to render him less desirous of change, and therefore more profitable to the employer.

Entering upon the premises of the Corliss Steam Engine Company, the eye is at once greeted by smooth-shaven lawns which surround the buildings, ornamented with trees here and there, and kept scrupulously clean. The buildings are substantial structures of brick, having a studied adaptation throughout to their special purpose. Appropriate and commodious business offices form the front of the structure, through which the visitor enters the machine shop, with all its grand effect of a vast and almost interminable "industrial hall," the length of which is perhaps most emphatically impressed upon the eye by the fact that the

parallel lines of the railway which traverses it are so extended as to seem to nearly converge at the farther end. This hall is replete with the most elaborate and effective machinery which the careful and painstaking experience of twenty years in the manufacture of the leading engines of the world, and the most subtle ingenuity, have combined to develop.

Passing through this long avenue of machinery, the eye constantly falls upon evidences of the most successful adaptation of means to ends for securing the greatest economies of labor, as well as the greatest perfection in the details of the machinery, of this the largest works in the world, making a specialty of the manufacture of stationary engines and boilers.

Pursuing the line of the railway we reach the wareroom, and, taking position upon a turn-table thirty feet in diameter, we find upon our right a track leading into the iron foundery, where immense castings are made; in front of us the track leading into the "erecting shop," where the engines are put together previous to being shipped; and on the left a track running into the boiler shop, but on the way crossing another turn-table, by which direct connection is made between the establishment and the Boston and Providence Railroad, and the Providence and Worcester Railroad, by which, in their connection with other railways, the establishment is enabled to transmit its manufactures to the remotest parts of the land without change of cars.

In these works an engine of five hundred horse power has lately been built in six weeks, though with a gear fly-wheel weighing twenty tons, turned upon its face with the accuracy of clockwork, and finished with cogs for the transmission of that great power. The establishment enjoys the distinction of having made the heaviest spur gear ever made in the world, — that of the Wamsutta Mills, in New Bedford, Mass., it being thirty feet in diameter, twenty-four inches wide on the face, and weighing, when completed, over fifty tons.

It is safe to say that more heavy gearing has been cut in this establishment in the last twenty years than in all the world beside; and the proprietor is now (1871) at work upon new and improved appliances, which must secure to him in the future that which has been awarded him in the past, the leading position in this important branch of the business.

In the manufacture of steam engines, as in many other departments of constructive industry, the use of costly special ma-

chinery for the perfection of an efficient system is practicable only in connection with a very large business. Fully considering this, Mr. Corliss is preparing to quadruple the productive capacity of his establishment. As the initiatory step, he has already introduced steam hammers, for forging the heaviest work required.

Although the business of this establishment is conducted under the name of the "Corliss Steam Engine Company," the establishment is, in fact, the exclusive property of Mr. George H. Corliss, and is conducted under his personal supervision. Mr. Corliss not only brings to his business his subtle and comprehensive mechanical talent, and long experience as a manufacturer, but also a peculiar aptitude for the mercantile department.

It is due to Mr. Corliss that we add that his whole establishment, inclusive of its special machinery as well as architectural adaptations, are the creations of his own brain, and, as his property, are fitting, though partial rewards, of his great contributions to mechanical science.

George H. Corliss is still in the vigor of middle age, and has, doubtless, before him a future in which he cannot fail to achieve still greater successes than have thus far distinguished his remarkable career. A native of Washington County, N. Y., academically educated at Castleton, Vt., he settled in Providence, R. I., in 1844, where he has since continued to reside. Aside from conducting his extensive business, Mr. Corliss has found time to attend to other matters, and, at the earnest solicitation of his fellow-citizens, has represented his district for three successive years in the Senate of Rhode Island, where he was assigned the position of chairman of the committee on finance. As an inventor, a scientific mechanician, a manufacturer, a business man, and a gentleman, Mr. Corliss exemplifies the best type of the American character, and is most worthy of imitation by the rising young men of the land. But perhaps nothing is more notable and praiseworthy in his career than the just persistence with which he has prosecuted the claims of his invaluable inventions to popular acceptance, and compelled their rightful recognition through tedious years of litigation to which he was subjected by rival manufacturers, not only vindicating himself, but successfully demonstrating the fallacy of their positions. A marked feature of Mr. Corliss's character is a large and discreet benevolence, quietly expressed in liberal donations to various charitable and educational institutions.

CALICO-PRINTING.

DERIVATION OF THE WORD "CALICO." — THE ANTIQUITY OF CALICO-PRINTING. — PLINY'S DESCRIPTION OF THE EGYPTIAN PROCESS. — THE PROCESS USED IN INDIA. — ITS INTRODUCTION INTO EUROPE. — RESTRICTIONS IN ENGLAND ON THE USE OF CALICO. — CALICO-PRINTING IN THE UNITED STATES. — DESCRIPTION OF THE VARIOUS PROCESSES NEEDED. — MORDANTS. — SOURS. — IMPROVEMENTS IN CALICO-PRINTING. — THE DIFFERENT STYLES REQUIRED BY THE DIFFERENT MARKETS OF THE WORLD.

THERE is a town in India, in the province of Malabar, the territory of which was given, centuries ago, by the first monarch of that province, to one of his chiefs. He gave to that chief his sword, with all the land in the limits of which a cock crowing at a small temple could be heard. This formed the original dominion of the Tamuri, to whose ancestor it was given, and was called *Colicoda*, or the cock-crowing. It came afterwards to be called *Calicut*, where large quantities of cotton goods were manufactured, and were imported into England under the name of *Calico*. This word is applied to white cotton cloth in England; but in the United States it is given to all colored or printed cotton cloth. In France it is called *Indienne*; in Italy, *Indiana* (tela), indicating the country from which the art of calico-printing was received by Europeans.

Calico-printing is the art of impressing colored patterns or designs on white cotton cloth. Doubtless before any printing, properly so called, was done, cloth was painted by hand, and also woven in colored designs. Herodotus speaks of a people on the shores of the Caspian Sea who painted the forms of animals on their garments with vegetable dye. "They have trees whose leaves possess a peculiar property; they reduce them to powder, and then steep them in water; this forms a dye or coloring matter, with which they paint on their garments the figures of ani-

mals. The impression is such that it cannot be washed out; it appears, indeed, to be woven into the cloth, and wears as long as the garment itself."

In an earlier age, it was said, "Now Israel loved Joseph more than all his children, because he was the son of his old age, and he made him a coat of *many colors.*" Whether this coat was woven or painted cannot be determined. The king's daughters, who were virgins, were apparelled in garments of divers colors. It is said to be a custom in India to clothe a favorite child in a coat of many colors, because it is believed that neither tongue nor evil spirit will injure him, the attention being taken from the beauty of the person to the brilliant colors of the garment. The "glowing purple of the Tyrian dye" was greatly esteemed in very early times, and was often appropriated as the color of royalty. The kings of the Midianites, defeated by Gideon, were clothed in purple raiment. The pagan nations were sometimes accustomed to array the images of their gods in robes of purple. When the prophet Ezekiel took up a lamentation for Tyre, he spoke of the "blue and purple from the Isles of Elishah," in which the people were clothed. This reference is doubtless to the islands of the Ægean Sea, from whence the Tyrians obtained the shell-fish, — the murex and the purpura, — which produced the dark-blue and bright-scarlet coloring material, the use of which contributed so much to the fame of ancient Tyre.

From an account given by Pliny of the nature and process of coloring cloth practised by the ancient Egyptians, it may be inferred that they had attained great skill in what is now called the art of calico-printing. "An extraordinary method of staining cloths is practised in Egypt, being first imbued, not with dyes, but with dye-absorbing drugs, by which they appear to be unaltered, but when plunged for a little in a caldron of the boiling dye-stuff, they are found to be painted. Since there is only one color in the caldron, it is marvellous to see many colors imparted to the robe in consequence of the modifying agency of the dye-absorbing drugs. Nor can the dye be washed out. Thus the caldron, which would of itself undoubtedly confuse the colors of cloth previously dyed, is made to impart several dyes from a single one, painting while it boils."

Calico-printing or calico-painting has been one of the industries of India for centuries, and is practised with an extraordinary skill. In the town of Muhlhausen, greatly celebrated for calico-printing,

are exhibited specimens of modern Indian calico in the preparation state, topically covered with wax, to serve as a resist to the indigo dye; and also ancient styles of pencilled cloth covered with most complex figures, the execution of which must have required the highest degree of intelligence and skill. Among other curiosities, the counterpane of a state bed is shown, six yards long and three broad, which must have taken a lifetime to execute, on their plan of applying the melted wax with a pencil. Modes of printing similar to those practised in India have been long known in Asia Minor and in the Levant, also in China. The cottons and nankeens of the Chinese are renowned all over the world. They excel also in making flowered satins, and other silk stuffs, which from time immemorial have attracted the merchants of Asia.

From India the art of calico-printing was introduced into Europe; some towns in France particularly became celebrated, and are so still, for printed cottons of brilliant and fast colors. The art was introduced into England in the year 1696. But it was not till after the middle of the last century, about 1768, that calico-printing was commenced in Lancashire, where it now constitutes one of the most interesting and productive branches of English industry. The introduction of calico into England encountered great opposition from the silk-weavers, who often assailed in a riotous manner the East India House, because the company imported the chintzes of Malabar. The government yielded to the remonstrances of the silk trade, and imposed heavy duties on Indian calico, and afterwards prohibited the importation altogether.

In the year 1720 the wearing of all printed calico whatsoever was prohibited by a new law, passed in order to quiet the clamor of the woollen and silk manufacturers. Ten years later Parliament permitted the manufacture and wearing of printed cloth made of cotton weft and linen warp, imposing on it a duty of sixpence the square yard. In 1774, after a most expensive application to Parliament, cloth made entirely of cotton was allowed to be printed under certain burdensome restrictions, though cotton cloth was much better suited for printing than mixed webs of cotton and linen, which received the colors unequally, owing to the unequal attraction of these two fabrics for dyes. Calico-printing in England continued to be the subject of oppressive laws till the year 1831, when they were all repealed; and the business, left to its natural development, under the taste, skill, and capital of the coun-

try, had a great increase; so that in a brief period a single manufacturer in Manchester produced a million of pieces in one year.

Large establishments for calico-printing are found in the New England and in some of the Middle States. The quantity produced in the United States nearly equals the production of England, though the quality of both English and French calico is superior. The consumption of calico in the United States is greater, in proportion to the population, than that of any other country in the world. Calico-printing in our country is more remarkable for mechanical power and speed than for taste. The mode of business, forced in many instances by large capitals on the joint-stock system, differs entirely from that of Great Britain. The cost of production is also much higher, from high-priced labor, coal, and drugs. As early as the year 1824, the product of printed cottons in the New England States amounted to sixty thousand yards per week. In the year 1860, the product of printed cloths in the same States amounted to two hundred and seventy-one million eight hundred and fifty-seven yards, or an average of five million two hundred and twenty-eight thousand yards a week.

Cotton cloth intended for printing must be subjected at the outset to the operation of singeing, for the purpose of removing the fibrous down or nap. There are two methods of accomplishing this. One, the old method, consists in passing the cloth rapidly over a semi-cylindrical bar of copper or iron, kept at a bright-red heat, placed horizontally over the flue of a fireplace situated immediately at one end of the bar. The new method consists of a horizontal range of gas-jet flames, over which cloth is drawn by rollers, with a continuous rapid motion; a line of suction-tubes is placed over the extended web, to draw the flame up through the interstices of the cloth, which effectually clears the thread of down. The apparatus used for this method of calendering is the invention of Mr. Samuel Hall, of Basford, England; and when it is so arranged as to allow the passage of two pieces of cloth at the same time over two gas flames, is capable of singeing fifty pieces of cloth per hour.

After singeing off the loose, downy threads, the cloth must be well bleached. Bleaching means the whitening of cloth by the removal or destruction of substances which color it. The term, however, has a more extended meaning, and besides whitening, bleaching is understood as a process which prepares the cloth for

dyeing. The whiter cloth is, the more light it will reflect from its surface, and the more brilliant will be the color of its dyes. Though for dyeing purposes whiteness is not always an essential point; what is essential is the removal of certain substances which exist in the fibre, and are inimical to the entrance of the dye. If light and bright shades are required, it is necessary also that the fabric should be free from the dull-gray color naturally belonging to it; but for dark and heavy colors this is not necessary. In any kind of dyeing, where part of the fabric is intended to remain white, as in dyeing after printing, both points must have careful attention; the cloth must be a good white, and free from all foreign matters, because otherwise the white parts would become tinged with the dye, and it would not be possible to restore the white to its original brilliancy without at the same time injuring the colored parts of the design. So that bleaching for printing is a most difficult part of the art, and requires the greatest care and skill to accomplish it in a satisfactory manner.

The first operation in bleaching cotton cloth is *steeping* or *wetting out*. It is placed for a number of hours in cold or tepid water; this is sometimes called the *rot steep*, and very heavy goods are wetted out with boiling water. The object of this steeping is to remove the dirt and greasy matters and metallic particles, which have accumulated upon it in the course of gathering, packing, and storing the cotton, and manufacturing it. The goods are then thoroughly washed from this steep in the dash-wheel, or tramped in water, and then washed by rinsing them through water with the hands: they are then ready for the boiler.

The next step in the bleaching process is called *bowking* or *liming*. The bowking apparatus is a large, egg-shaped caldron, with a false, flat bottom, placed a little above the rounded true one, to protect the cloth from all danger of being scorched by the fire. Through the centre of this false bottom a pipe rises from near the real bottom to a short distance above the top of the caldron. The boiler being filled with goods, and supplied with a proper quantity of the detergent liquid, is securely covered with a dome-shaped lid. When the boiling becomes active, the steam forces a constant stream of liquid up the central pipe, causing its constant overflow, whereby the goods are constantly wetted and soaked with the boiling-hot ley of lime. The action of the lime in bleaching is simply a preparatory one; it prepares the way for the soda-ash, softening the matters to be removed; but it actually

removes very little more than a similar boiling in hot water would. The goods are then washed from the boil, and allowed to drain, the draining being facilitated by pouring hot water upon them; they are then hanked up, taking out all the twists, and laid into vats of bleaching liquor as loosely as possible. When the cloth has been allowed to steep in the bleaching liquor for some hours, it is again washed out, and subjected to the *souring* process. The passing of the goods through the *sours* takes out any lime that may have become fixed upon the cloth, either chemically or mechanically. It decomposes the lime soaps by taking the lime from the fatty matter, the fatty matter yet adhering to the cloth, but in an altered or acidified state, in which it is easily acted on and dissolved by soda-ash.

After washing out of the *sours*, the cloth is subjected to boiling heat for several hours in alkaline ley made of crude soda. The goods are again rinsed, and finished by a steep for an hour in vitriol and water. By these means all oily and resinous matters, particles of iron or iron rust, all foreign substances usually found in good cotton, are removed.

"There are very few dye-stuffs capable by themselves of imparting to cotton colors of sufficient lustre and durability combined. They are rendered fast as well as brilliant by the intervention of certain substances, which, in consequence of their attraction for the cloth and the coloring matters, form a bond of union between the two, and are on that account sometimes called bases, and at other times mordants, from their taking firm hold of or biting the dyes. These intermediate substances, though colorless themselves, possess the power of modifying the color of the dye, or of producing from the same dye-stuff different tints; so that a piece of white cloth, after being imbued with various mordants, will assume various colors in a single dye vat. Thus, if white cotton be impressed with the mordant of acetate of alumina in one set of lines, with that of acetate of iron in a second, and with a mixture of these two mordants in a third, on being exposed to the madder bath for a proper time, it will become permanently printed in red, black, and chocolate stripes."

In calico-printing it is necessary that the mordant should be applied only to certain parts of the cloth, the remaining part either being left white, or occupied by some other mordant or color. If, however, a drop of mordant in its fluid state be applied to a piece of cloth, it spreads in a circular form far beyond the size of the

drop, but not in an equable manner. This inclination of liquids to spread beyond the limits of their first application, is overcome by thickening them with various substances, such as gum, flour, sugar, molasses, glue, starch of potatoes, of rice, and of sage. These thickeners constitute a great item of expense in calico-printing; as the large quantities of these substances, which are derived for the most part from articles of human food, after having accomplished their purpose, are a complete loss. The thickening of mordants and colors is one of the important operations in calico-printing; on this so much depends in the way of obtaining good results that it may be considered as the most important part of color-mixing; and that a color-mixer will be good, bad, or indifferent, as he instinctively perceives the importance of this branch of his art, and is successful in carrying it out. While most of the other substances employed in this work leave some traces of themselves on the finished product, the gum, starch, flour, etc., used as thickeners, are only temporary in their application, and have to be all removed before the colors are finished.

When the cotton goods are properly prepared by calendering and bleaching, and the mordants thickened and mixed with colors, they are ready for printing. There are several mechanical modes of printing calico. (1.) The old method of printing by blocks is still in use. The blocks are generally made of sycamore wood, about ten inches long and five inches wide, with an arched handle on the back. The face is either cut in relief into the design required, or the same object is obtained by means of slips of copper inserted edgewise, filed down and polished, to secure equality of impression in the several lines. This renders them more durable, as frequent applications diminish the distinctness of outline of their designs or figures. Calico-printing by hand is performed by applying the face of the block first to the coloring material and then to the cotton cloth spread on a smooth table covered with a blanket; the impression is transferred to it by striking the block with a light mallet. A second and third color is applied to the cloth by using a second or third block, so engraved as to fill in the vacancies left by the preceding. This method involves great cost of labor, and is attended with irregularities in the execution of the work.

(2.) The usual block-printing method was to a great extent superseded by the Perrotine, a machine of most novel and elegant description, the invention of M. Perrot, of Rouen. "Three thin

wooden blocks, engraved in relief, about three feet long and from two to five inches broad, are successively brought to bear on three of the four faces of a prismatic roller of iron, round which the cloth is successively wound. Each block rests on springs, which enable it to press with the delicacy of a skilful arm, and each receives its peculiar colored paste from a woollen surface, imbued by a mechanical brush in rapid alternation." This machine operates with great speed and precision; so that one man, and three boys to superintend the three colors, could do the work of twenty men and as many boys in ordinary block-printing.

(3.) The introduction of cylinder printing has been the greatest improvement in this art. It is a machine which, with one man, can do the work of a hundred men and as many assistants by any other mode of calico-printing. The copper cylinders now generally used are hollow, or bored through the axis, about three feet long and from three to six inches in diameter. The surface of these cylinders is engraved, not by the ordinary methods of hand-engraving, but by the mechanical pressure of a steel roller, which transfers the figures engraved on it to the relatively softer copper. Sometimes the cylinders are covered with various figures by the process of etching. These cylinders, corresponding with the different colors to be used, are mounted on a strong iron frame, so as to pass against a larger central cylinder covered with felt, between which and the copper-engraved cylinder the cloth is printed as it passes. The engraved cylinder revolves in contact with an attendant roller, which dips into an oblong trough containing the mordants and the coloring matter properly thickened. It is cleared of superfluous coloring matter by the edge of a flat ruler made of bronze, called vulgarly the "doctor" (ductor), which is applied to it obliquely, leaving the depressions of the engraved cylinder filled with coloring, while the excess falls back into the trough. The cylinder thus charged with impressible color acts on the cloth, and rolls it onward with its own revolution, imparting its figured design with great precision. At one of the print works in Manchester, England, is a machine of this kind, capable of printing twenty colors. So rapidly do these machines operate that they print a piece of twenty-eight yards in a minute, or the length of nearly one mile of well-colored designs of exquisite beauty is printed in an hour. Such is the combined result of skill in machinery and art, and of chemical science, carried to a high state of perfection.

All goods after being printed must be placed in a hot-air chamber before having their colors brought up in the dye-house. But as more of the thickened mordants have been applied to the cloth than can be absorbed and retained, it must be subjected to a process of cleansing. This cleansing cannot be accomplished by a mere washing with water, as the excess of mordant liberated from one part of the cloth would be absorbed by another, where the design required a white or colorless part, or in the case of different mordants being on the same piece of cloth, they would intermix, and spoil one another. It became necessary, therefore, to find some fluid in which the cloth could be washed from the excess of mordant and the useless thickening matter, which at the same time should prevent the loose mordant from fixing itself on any part of the fabric. Such a fluid was found in a mixture of hot water and cow-dung. The dunging of printed goods has been regarded as one of the very important, though mysterious, processes in calico-printing, The heat of the cleansing liquor and its strength must vary with the styles of work, and be skilfully adapted to them. Too high a temperature and too much dung are injurious to delicate colors, such as the pinks and the yellows; colors thickened with starch require a higher temperature than those thickened with gum. The cloth should never be allowed to stop for a moment in its progress through the dung-bath, for the part in contact with the surface of the water would run, and cause a line mark across the cloth.

The goods must then be washed in the dash-wheel, or passed through a rinsing trough; then winched through a fresh dung-cistern at a lower degree of temperature; then washed again. They are then ready for the dye-bath.

There are several different styles of work in the process of calico-printing, each of which requires a different method of manipulation.

(1.) *The madder style,* to which the best chintzes belong, in which the mordants are applied to the white cloth, the colors being afterwards brought up in the dye-bath. On those portions of the cloth on which the mordant is applied the coloring attaches itself in a durable manner; but on the unmordanted portions the color is feebly attached, so that it may be wholly removed by washing, either in soap and water, in a mixture of bran and water, or in a dilute solution of chloride of lime.

(2.) *The padding style,* in which the whole surface of the calico is imbued with a mordant, on which afterwards different colored figures may be raised by the topical application of other mordants, joined to the action of the dye-bath.

(3.) *The resist style,* where the white cloth is impressed with figures in resist paste, which will protect the parts it covers from receiving any color, and afterwards subjected to a cold dye, as the indigo vat, and then to a hot dye-bath, with the effect of producing white or colored spots on a blue ground.

(4.) *The discharge style.* The object of this style of work is the production of a white or colored figure on a colored ground. This is accomplished by printing on the cloth already dyed or mordanted a substance called the *discharger,* which has the property of decomposing either the coloring matter or the mordant.

(5.) *The China-blue style,* which requires very peculiar treatment, and is practised with one coloring matter only, namely, indigo. The different shades of blue are secured by first printing with indigo in its insoluble state, and then reducing this to the soluble state, and dissolving it on the cloth by immersing it in certain chemical preparations.

All these different styles require a complicated process peculiar to each. The art of calico-printing has been carried towards perfection by the exercise of the highest mechanical ingenuity, the cultivated taste of the best artists, and the talent of the most distinguished chemists. "It is curious to consider the great variety of taste the calico-printer is obliged to consult. As articles of dress, his goods are to be worn by the half-clothed savage, fond of a display of gaudy colors; they are to please the refined tastes of civilized nations, of the women of Eastern harems, and the wives of African kings. Almost every country is a customer for these goods, and each demands peculiar styles, patterns, and colors."

NARROW GAUGE RAILROADS.

MODERN CHEAP TRANSPORTATION. — OUTLINE HISTORY OF RAILWAYS. — THE TRAMWAYS OF THE NORTH OF ENGLAND. — THE FESTINIOG RAILWAY. — EXCAVATION AND TRANSPORTATION WHERE PERMANENT RAILWAYS NOT WANTED. — THE PETELER PORTABLE RAILROAD PRECISELY ADAPTED FOR THIS BUSINESS. — MASS OF SUCH WORK IN ORDINARY RAILROAD BUILDING. — SAVING BY THE USE OF THE PETELER PORTABLE RAILWAY. — FACILITY OF HANDLING AND MOVING THIS RAILWAY. — SAVING IN TIME AND MONEY. — FACTS AND DETAILS IN ILLUSTRATION OF THIS ECONOMY. — ACCOUNT OF THE ORIGINAL INVENTION OF THE PORTABLE RAILWAY.

CHEAP transportation is the instrument and the test of civilized progress. In proportion as men can travel quickly, and easily, and cheaply, and can carry goods and materials quickly, and easily, and cheaply, very nearly in that proportion do wealth, and intelligence, and happiness — that is, civilization — advance.

In this branch of improvement railroads are the most recent forward steps on land, as steam vessels are at sea. In railroad improvements, the latest step is the adoption of very narrow gauges ; and, last of all, a recently organized American company — the Peteler Portable Railroad Company — have in one singularly ingenious step completed a circle of improvements by combining the vast economy of power which railways afford with a cheapness greatly beyond that of a horse and cart, and an ease and quickness of use which makes a railroad train almost as handy as a wheelbarrow.

A brief outline may be given of the course of this return to features of railway history nearly three hundred years old, while yet the modern improvements in railroad construction prevent this return from being a retrograde.

The first ancestor of the railway was the tramway, which, as its description will show, was a good deal more like the Portable Railroad of to-day than any of the intermediate generations. This

is according to that law which recent physiologists call "reversion," according to which, in any generation of men or animals, there may crop out, as it were, some trait which had been hidden perhaps for a century, but had been distinct in remote progenitors.

Tramways were first introduced in the coal mining districts of the north of England probably between the years 1602 and 1649, that is, under James I. or Charles I. They consisted of parallel lines of wooden *trams*, or beams, pinned down to the ground, and with flanges on these trams, not on the wheels. Coal wagons were drawn to and fro along these flanged trams from the coal pits to the shipping ports on the Rivers Tyne and Wear. Rent was paid to the owners of the lands over which these tramways were laid, and this rent was called *way-leave* — a term still used in that region for land damages for railroads. Roger North, writing in the year 1676, describes these tramways thus: "The manner of the carriage is by laying rails of timber from the colliery down to the river exactly straight and parallel; and bulky carts are made with four rowlets fitting these rails, whereby the carriage is so easy that one horse will draw down four or five chaldron of coal." Along one of these colliery tramways the English cannon were posted at the battle of Prestonpans, won by the Young Pretender and his Highlanders over Sir John Cope in the year 1745.

The first use of iron on these tramways was by nailing down iron plates on the timbers, to protect them where they wore out fastest. The first iron rails were cast at Coalbrookdale in 1767, to keep the furnaces going in a slack season. They were bars, five feet long, four inches wide, and an inch and a half thick, and whenever the price of iron should rise, they were to be taken up again and sold. All iron rails were cast until Birkenshaw introduced rolled wrought iron rails in 1820. Horse railroads were increasing in numbers in England — five having been chartered by Act of Parliament in 1805, sixteen in 1815, and thirty-two in 1825 — when the locomotive was first successfully constructed by Stephenson in 1829.

The width of the tramways was about 4 feet $8\frac{1}{2}$ inches, because that happened to be the usual width of the wagon tracks in that region. The same width was naturally adopted for the first railroads, and has ever since been used on more roads than any other in most parts of the railroad world. Fourteen other widths are known to have been used, — from seven feet (on an English line, the Great Western) down to two feet (on the now famous

little Festiniog Railway in Wales). The Spanish roads have the elaborate fractional width of 5 feet $5\frac{13}{16}$ inches.

The Festiniog Railway is that whose construction and operations are most nearly like the Portable Railroad of the Peteler Portable Railroad Company. It was built to haul slate from a Welsh quarry down to a seaport, and has been running for nearly forty years, by horse power until 1865, when locomotives were placed on the road, and with so much success, as to economy and efficiency, as to have of itself alone practically decided the narrow-gauge question.

Some occasional discussion of this comparatively new idea of very narrow railways has taken place during the last year or two in the United States; and here, as well as in Europe, a number of permanent steam railroads on a similar plan are in process of organization or construction. There is required, however, every year, an immense mass of transportation and excavation, for which a permanent railway is not wanted. This is at present executed by the old-fashioned means of wheelbarrows, carts, or wagoning, and it is for the economical and rapid performance of this work in particular that the portable cars and track of the Peteler Portable Railroad Company are peculiarly adapted.

Such cases are — the transport of stone, brick, and timbers from a quarry or dock to a building; filling up low grounds; levelling and embanking for wagon roads and railroads; building mill-dams; working peat bogs; sanding cranberry meadows; building levees; running brick-yards; filling ice-houses; many portions of military transportation; for excavating and hauling at quarries, iron mines, coal mines, marl pits, gravel pits, etc.; for levelling and filling in the grading of public parks, cemeteries, and other large areas; for the heavy hauling at rolling-mills, founderies, boiler-shops, and other large iron works; at lime-kilns; in digging for large cellars, excavating for gas-holders, etc., etc.

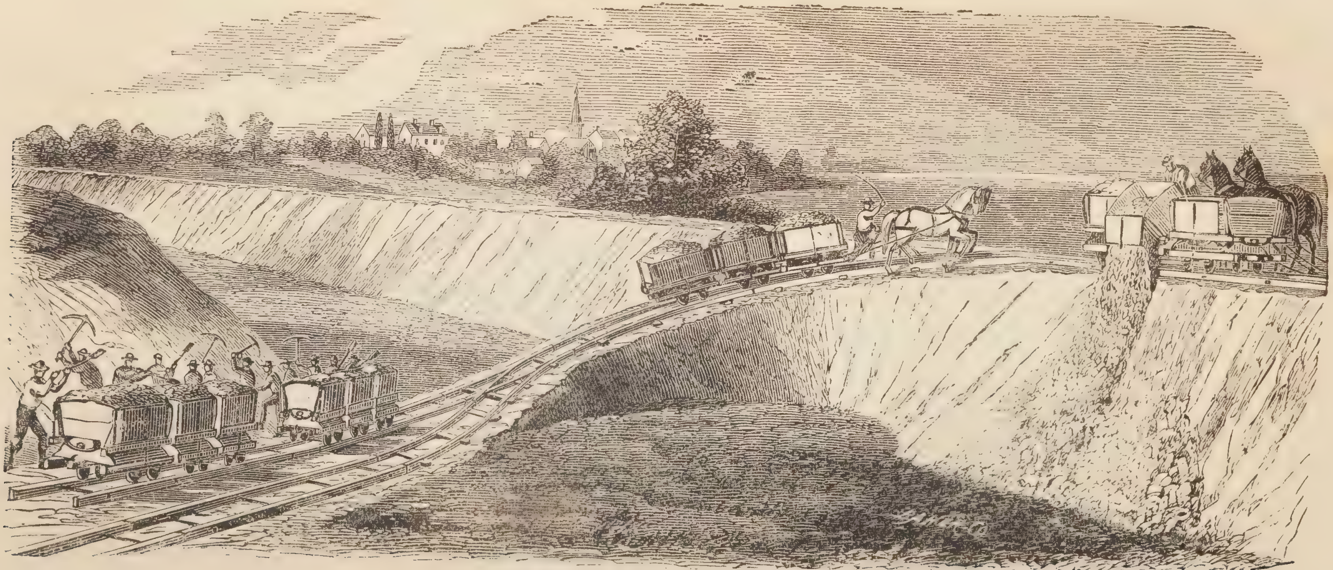
The statistics do not exist for estimating the quantity of such work which is every year executed in the United States, either by number of men, or horses, or vehicles employed, or by number of cubic yards or tons' weight moved. But an estimate of what may be expected from one single item of the above list will sufficiently indicate the vastness of the total. Mr. H. V. Poor, a most experienced and sober statistician, and a first-class authority on the railroads of the United States, calculates that new railroads have been built, during the last twenty years, in this country, at the rate

of two thousand miles a year; that this is to be three thousand miles a year hereafter, and more too; that the whole length of railroads now in operation in the United States is (on January 1, 1870) forty-seven thousand miles; and that it will take at least two hundred and fifty thousand miles more of railways to supply even moderately the whole of the United States.

Now, if we imagine the quantity of hauling required for the deep cuts and high embankments that must be made, for the timber, stone, and iron that must be hauled for the superstructures, bridges, etc., for this distance of two hundred and fifty thousand miles, which is more than nine times the distance around the world, and if we add some imagination of the further mass of heavy excavating and hauling required in all the mining, banking, filling, and other earth work of the United States, — which will be far greater in the total than this railroad item, — although we shall have no arithmetical figures for a result, it is impossible not to be convinced that the whole work laid out is enormous to a degree even beyond the intelligent grasp of the mind. It follows, of course, that the invention which diminishes the labor and cost of all this drudgery, directly and very greatly increases the sum of human wealth and happiness.

An easy comparison will show how greatly the Portable Railroad does diminish this cost and labor. One horse and man on the Portable Railroad can move at least five cubic yards of earth. This would be from ten to fifteen ordinary cart loads, for in practice, one cubic yard makes about three horse-cart loads; the same quantity makes sixteen average wheelbarrow loads. One man alone, with one of the smaller sizes of portable cars and track, can move a half cubic yard of earth, equal to eight wheelbarrow loads. Therefore the Portable Railroad enables one man to do eight men's work, and enables one man and horse to do the work of at least ten men, ten horses, and ten carts. It is easy to compute the saving.

"Portable" is the most important idea in this latest of the railroads; for it can be carried hither and thither, laid down, used, picked up, and carried away again, almost as fast as the field telegraphs that have played so important a part in the military campaigns of the last twenty years. The track is manufactured in twenty-foot sections, hitching strongly and securely together at the end by means of a hook-and-eye contrivance. The necessary short lengths, turn-outs, single and double curves, frogs,



THE PORTABLE RAILROAD IN OPERATION

cross-roads, turn-tables, etc., are all kept ready made and fitted with hooks and eyes in like manner. The rails are laid directly on the surface of the ground, without sleepers or any preparatory grading or digging. On level ground two men can lay down a thousand feet of the track in an hour, and can pick it up again in fifteen minutes. If there is a marsh or a bog, where an ordinary team could not pass, a "track-raft" has been contrived, which carries road, cars, and all, and a flying bridge is ready for canals and small rivers. A single railroad car, or three two-horse teams, can easily transport the whole track and fixtures of a Portable Railroad a thousand feet (about one fifth of a mile) long.

The patents which are owned by the Peteler Portable Railroad Company are two in number, one covering the track, and the other the peculiar dumping car which is used with the road, and which is of itself an ingenious and efficient contrivance for handling heavy materials. The car used for earth only requires that its load shall be lifted two feet eight inches from the ground, instead of five or five and a half feet, into an ordinary car or cart body. Any man who has ever shovelled one load of earth into a cart will readily see what a relief and saving it is to cut down by half the hoisting of the whole load. For materials like timber, brick, or stone, which will stack closely, this item of convenient handling becomes still more important, the platform for this purpose being only ten inches from the ground.

It is calculated from the results of the work thus far done by the Portable Railroad, that the saving it secures on heavy pieces of transportation is from half to three fourths of the time, and from one quarter to one half of the money, that would be required by the old methods. As in fixed railroads, these savings may become more or less, by virtue of some local peculiarity. Thus, if the ground traversed be of a suitable slope, the cars can be carried one way by gravity alone, and then, of course, so much of the work of transportation is saved.

A few specific details of work actually done will aptly illustrate these general statements.

In filling a wharf at the United States Light-house Depot, Staten Island, it turned out that, with the Peteler Portable Railroad track and cars, the quantity of earth moved was over twenty cubic yards per day per man, while with carts and horses, each man would have moved, on the most liberal estimate, not over $11\frac{1}{2}$ cubic yards. In sanding some cranberry meadows at Franklin,

Mass., and at Westbrook, Conn., where the ground was so soft that the horse used had to wear what may be called mud snow-shoes, made of board, the Portable Railroad — with one horse and six cars — did the work with a speed sometimes thirty times, and never less than twenty times, as fast as a wheelbarrow force could have done it. A canal and railroad contractor in Indiana wrote that he was embanking and excavating at one third the cost of using horse-carts. Dacey & Co., contractors on the Cape Cod Railroad, upon a careful and extensive trial, moved a thousand cubic yards a month more with a portable track and cars than with an ordinary train and track of $2\frac{1}{2}$ yard rotary cars, worked with an equal gang. Mr. Whyte, who hired twenty cars and fifteen hundred feet of track to make excavations for his great gas-tank for the New York Mutual Gas Company, reported that he had saved fifty per cent. on his contract in consequence. A Connecticut cranberry man, Mr. Bill, of Lyme, wrote that he had been sanding a cranberry meadow a mile long with the portable track, and that it enabled him to do the work for one third of what it must have cost in any other way, and that his saving on that one job would "pay for the cars and track twice over." Town Road Superintendent Seymour, of Hingham, Mass., found that, even at short distances, such as three hundred feet, he saved one fourth the cost of wheelbarrow hauling, and one third over that of carting.

A long list of similar statistics might be reported from documents on record, not to mention the numerous general statements of "saving both time and money," "having a decided advantage over horses and carts," and the like.

Perhaps the most interesting illustration of the flexibility of the Portable Track was shown in a job of city filling at Boston, where it was found that wheelbarrow work was slow and expensive beyond endurance, and where horse-carts could not go. The gravel used in this work was to be filled in from six to eighteen feet deep, in a low and ill-drained part of the city, built over, however, and where the houses were to be raised to the new level, and the filling dropped and packed in, as the case might be, in side streets, alleys, back yards, and cellars, at all sorts of depths. It was, however, found that the road was, one might almost say, as flexible as a string; it twisted and squirmed up and down, and in and out, round corners and through back gates and cellar doors, searching out one hollow after another, ever and anon being picked

up and carried in at a new place as they carry the hose at a fire, until the whole was successfully accomplished, and at the rate of three hundred cubic yards a day to twenty men, too; being fifteen cubic yards, equal to thirty heavy cart loads, per man.

It is scarcely necessary to say that a mode of transporting which possesses at once more than the adaptability of a man with a wheelbarrow, at half the cost; more than the wholesale economy of a railroad gravel train, without its burdensome permanency; which can go where man and horse cannot; which cannot be disabled by rain, flood, sand, or mud; and which can be laid down in an hour and removed in fifteen minutes, without leaving a remnant or trace of its presence, is the very beau-ideal of a transportation system. The credit of the inventions which are united in the Portable Railroad enterprise is due to a Bavarian engineer officer, Herr Peteler. During the military operations of the famous campaign which was closed by the decisive defeat of the Austrian army at Sadowa, in 1866, there arose a necessity for quickly filling in an area of marshy ground. The means were not at first forthcoming, but Herr Peteler quickly conceived the idea of the movable narrow tramway, the light cars, and the track-raft which was to carry them over the morass. The necessary woodwork was extemporized, and the filling executed with unprecedented quickness. The efficiency of the plan was thus proved, and the inventor proceeded to develop and complete its adaptation to civil as well as military operations. When his inventions were complete, he went on to introduce them in Europe, and intrusted his brother, Mr. Alois Peteler, with the business of bringing them into use in America. The undertaking has already met with great success, the track and cars of the Company being now in use in more than half of the states, and in the British Provinces, Cuba, and South America.

SEWING SILK AND MACHINE TWIST.

THE ORIGIN OF SILK. — MANUFACTORY IN CHINA. — INTRODUCED INTO VIRGINIA. — ATTEMPTS IN THE OTHER COLONIES. — FIRST SILK RAISED IN CONNECTICUT. — BOUNTIES AND STATE AIDS. — THE PROFITS OF THE BUSINESS. — ITS DECAY. — THE REVIVAL OF SILK CULTURE. — THE INTRODUCTION OF MACHINE LABOR. — THE INCORPORATION OF THE MANSFIELD COMPANY. — MACHINE TWIST. — INTRODUCED BY THE NONOTUCK SILK COMPANY, OF FLORENCE, MASS. — INCREASE OF THIS BUSINESS. — PREJUDICE CONCERNING ITALIAN SILK. — ITS EFFECTS. — THE TRUTH IN THE MATTER.

SILK, as is well known, is the fibre from the cocoons, or nests, which insects build for their protection while in the chrysalis condition. The chief supply is, however, derived from the silkworm, a caterpillar which lies upon the mulberry tree, and is classed scientifically as the *bombyx mori*.

The manufacture of silk has been known from the earliest times in China. From there it was introduced into Europe during the middle ages.

At the settlement of the United States, various attempts were made to introduce the culture of silk. At a meeting in London of the company under whose auspices the settlement at Jamestown, in Virginia, was made, held in London in 1620, Sir Edwin Sandys, whose term of office as treasurer had just ended, made an address concerning the affairs of the colony, in which he recommended the culture of mulberry trees, and the raising of silk, saying that the king, James I., had sent a second supply of silkworm eggs to the colony from his own stores.

Though at frequent intervals the authorities suggested the culture of silk, and sought to stimulate it by rewards and bounties, yet in these early days very little attention was devoted to it.

In 1718 this culture, with that of indigo, was introduced into Louisiana by the "Company of the West;" and during the Rev-

olution the chief supply of sewing silk for the upper country was derived from the silk works established in Georgia by the French settlers. The business had been founded there by most liberal appropriations from Parliament and private persons in England. Lands were given settlers upon condition that they planted ten mulberry trees for each acre, and the seal of the founders, with its motto, "*Non sibi, sed aliis*" (not for ourselves, but for others), with the representation of silkworms, expressed at once both the spirit with which the enterprise was undertaken and its object. Skilled workmen from Italy were sent over to superintend and instruct the settlers; but becoming dissatisfied, they destroyed the stock and machinery, and fled into Carolina.

Others were, however, sent over to recommence the business; and in 1734 the first shipment of eight pounds of raw silk was sent to England. The business continued, increasing in proportion to the bounties awarded it, reaching, in 1760, fifteen thousand pounds of cocoons: but when the bounties were discontinued, it diminished rapidly, and in 1790 the last silk was shipped from Georgia.

In Carolina, also, the culture of silk was a somewhat fashionable employment for the ladies during the latter part of the last century.

In Massachusetts fine samples of sewing silk were made in 1790 by Mr. Jones, of Western, in Worcester County. In New York, New Jersey, and Pennsylvania attempts were also made at an early period to introduce this culture. In 1769 the American Philosophical Society, of Philadelphia, on the recommendation of Franklin, commenced a subscription for establishing a filature of silk in Philadelphia, under the direction of a Frenchman. A Mrs. Wright, a Quakeress in Columbia, Lancaster County, made a good deal of sewing silk in 1770. In the Philadelphia Library Company are preserved samples of a silk dress, for the Queen of England, made from silk raised by Mrs. Wright. They are in the manuscript of Watson's *Annals of Pennsylvania and Philadelphia.*

In Connecticut silk was early produced, and was the subject of legislation in 1732. President Styles, of Yale College, was earnest and constant in his efforts to stimulate the culture. He commenced by planting three mulberry trees in 1758, and in the library of Yale College is his manuscript journal, in which are recorded his experiments and efforts, extending over a period of nearly forty years. In 1747 Mr. Law, the governor of the state, wore the first

coat and stockings made of New England silk, and in 1750 his daughter the first silk dress made from domestic material.

The state government took an interest in the establishment of the industry, and distributed to every parish half an ounce of white mulberry seed, a variety suitable to the climate, and offered a bounty for the production of mulberry trees and raw silk. In 1760 the Rev. Jared Eliot, of Killingsworth, stated, in his *Essays on Silk-growing and Field Husbandry in New England,* that one of the principal cultivators of silk, whose credibility could be relied upon, informed him that he could make a yard of silk as cheap as he could a yard of linen cloth, of eight run to the pound, and that it was then considered "more profitable than any other ordinary business."

In 1789 the town of Mansfield, where the culture appears to have been most successful, and where it has lasted until this day, made about two hundred pounds of raw silk, worth five dollars a pound. The sewing silk made at this period was worth one dollar an ounce.

The Revolution had depressed the business, and extinguished it in some localities; but now it began to excite new attention. In 1793 two hundred and sixty-five pounds were raised; and from this time it increased until the yearly production came to be about three thousand two hundred pounds, at which it remained until a blight in the seasons of 1843–4 attacked the mulberry trees, and, combined with the disastrous results of the *morus multicaulis* speculation, which had spread through the country like a pestilence, caused a distrust, and an almost entire abandonment of the pursuit.

The culture of silk has consequently lain almost dormant, until within quite recent times attention has been again called to it. Its successful introduction into California has again excited interest in the business, and there is no doubt that it can be made a most successful branch of agricultural industry in many different parts of the country.

Before 1828 the silk raised in the United States was all spun by hand upon the common spinning-wheel in use at that time. About this time Edmund Golding came to this country from Macclesfield, England, and settled at Mansfield, Connecticut, expecting to find it, from the reports he had heard, an important place for the working of silk. Though only seventeen years of age, he was an experienced throwster, and, disappointed at finding no opportunity

for employment in the occupation upon which he had relied for his support, he interested some of the residents of the town in his description of the simplicity of the machinery required, and together they resolved to construct it under his direction.

These men were Alfred Lilly, William A. Fisk, Joseph Conant, William Atwood, Jesse Bingham, and Storrs Hovey. Incorporating themselves under the title of the Mansfield Silk Company, they each contributed to the general fund fifty dollars, which was afterwards raised to seven hundred dollars. Having received also a bounty from the state of fifteen hundred dollars, the company appeared for some time to be prosperous; but want of experience and other causes, of which it would be difficult to give an accurate description, led to their embarrassment.

It would seem that the time was as yet premature for the successful establishment of the business, and the partners, their hearts made sick by deferred hope, retired, one after the other, until only two of them remained long enough to retire from it without loss. Very few industrial enterprises in this country have been attended with higher hopes and more utter failure than the various attempts to establish the silk business; but the time has now come when the manufacture is successfully established; and doubtless the period is not far distant when, in the westward march of empire, the United States will succeed to the leading position in this industry.

With the introduction of the sewing machine, it was found that the sewing silk then made was not in all respects suitable for using on it. After spending much time in experiment, the Nonotuck Silk Company, of Florence, Mass., succeeded in producing a machine twist which was found to be exactly the thing needed. The first lot of this new industrial product was made and spooled in February, 1852, and being tried by the Singer Sewing Machine Company upon their machines, was found to be just what they had been desiring to find.

From that time to this the demand has steadily grown, until now there are more than fifty manufactories in the country engaged in its production. Of these the chief one is the Nonotuck Silk Company, who first introduced it. Dating back their record in the silk business to 1838, they have increased with the increase of the silk business, until now they give constant employment to three hundred and fifty hands, and are the largest producers of their special wares, not only in this country, but in the world.

The demand for machine twist is greater in this country than in any other, since the sewing machine, as a purely American invention, has become so much more generally adopted in both factory and domestic use. Yet it is singular that the prejudice in favor of Italian silk should still be so strong, that, though in fact the supply of real Italian silk imported is wholly inconsiderable, almost the entire supply being furnished by American manufacturers, yet they are forced, in deference to this prejudice, to put it up in packages imitating those used in Italy, and to use as trade-marks the names of supposititious Italian firms.

It would seem as though it was time for the American public to free themselves from this childish deference to foreign names, and, becoming aware of the importance of this industry, put the manufacturers no longer under the necessity of thus appearing to be sailing under false colors.

HINGES.

THE FIRST HINGE, BY THE TRAP-DOOR SPIDER. — LEATHERN HINGES. — THE FIRST PIVOT HINGE IN ANCIENT EGYPT. — THE GREEK AND ROMAN HINGES SIMILAR. — INTERESTING ANCIENT PIVOT HINGES IN THE RUINED CITIES OF BASHAN. — DIMENSIONS AND HANGING OF STONE DOORS. — DIFFERENT PRINCIPLES OF THE ANCIENT AND MODERN HINGES. — ORNAMENTAL HINGES IN THE MIDDLE AGES. — MODERN HINGES. — USUAL SELF-CLOSING ARRANGEMENTS. — THE AMERICAN SPIRAL SPRING BUTT. — PRINCIPLE OF ITS MECHANISM. — OPERATION OF THE SPIRAL SPRING BUTT. — THE DOUBLE-ACTION PATTERN, THE ONLY CENTRE-REST HINGE IN THE MARKET. — ITS MECHANISM ILLUSTRATED BY THE LETTER Z. — DESCRIPTION OF THE DETAILS OF THE PARTS OF THE SPIRAL SPRING BUTT. — ITS SUCCESSFUL INTRODUCTION AND INCREASING USE. — ATTEMPTS TO STEAL THE PATENT.

THERE were hinges long before doors or houses were made by man. The trap-door spiders of warm climates lined their earth-dug nests with silk, closed them above with a neatly fitted door, and hung this door by a delicate and flexible, yet strong and serviceable, hinge, permitting the door, when opened, to fall back to its place by gravitation, ages before man had reasoned himself into anything better than a hole under some rock, and a still longer time before Newton had ascertained the law, or given the name, of gravitation. It is extremely probable that the earliest hinge used by men was of a sort still common enough — a piece of leather, or untanned hide or skin, fastened to both door-post and door.

It is in Egypt that the earliest record is found of the substitution of the actual hinge idea, viz., a pivot or joint, in place of a mere flexible texture. The Egyptian doors turned on wooden or bronze pins, projecting upward and downward from the top and bottom of the back of the door, into sockets in the lintel and threshold; and similar pegs were used by way of hinges on the lids of boxes. The same arrangement was employed in the domestic architecture of the Greeks and Romans, and it became usual

to have the upper pin or pivot a little nearer the middle of the doorway than the lower one, the back of the door sloping accordingly, so that the top of the doorway was narrower than the bottom. It is evident that when the door thus hung was opened to a right angle, for instance, the whole door would have the same slope with the part behind it, so that when let go, it would fall back of itself to the shut position. It was not only "hung," in the usual sense of the term, but it did really hang forward into the shut position, being held there by gravity.

A curious style of ancient hinge is found in the interesting ruins so numerous in what constituted the kingdom of Bashan, on the eastern boundary of the northern part of Palestine. Here is a strange area of bare basaltic rock, rising up from the more fertile land around it as suddenly as a wall, and thickly set with deserted towns, whose houses are so well preserved as to be still habitable, being built of slabs of the basalt itself, a black stone, as heavy, and almost as hard, as iron. Few travellers have examined this singular region. Among them may be mentioned Burckhardt, Freshfield, and Porter, the latter of whom thus describes the door of a house in Burâk, one of these deserted cities: "The outer door was a slab of stone, four and one half feet high, four feet wide, and eight inches thick. It hung upon pivots, forming two projecting parts of the slab, working in sockets in the lintel and threshold, and though so massive, I was able to open and shut it with ease." An inscription on one of these buildings, in Greek letters, was believed by Burckhardt to bear the date of 306 B. C., being more than two thousand one hundred years old.

These ancient hinges were projections from the door, in the prolongations of a perpendicular line through the substance of the door itself. They were like the two ends of a spindle run through the length of the door. The modern hinges are not ends, but sections out of the length of a spindle, not through the door, and playing above and below it, but between door and door-post, and held to one by a bolt carrying the spindle or pivot, and to the other by the eye that rides on the pivot. Through all the modifications of "esses," cross-garnets, H, and H L hinges, etc., etc., these three elements can be discerned, viz., the pivot, the piece that carries it, and the piece that rides upon it.

During the middle ages hinges were made ornamental as well as useful, although no improvements were effected in the mechanism itself. This ornamenting was chiefly managed by means of

the attachments upon the door, which were worked into graceful floriated curves, pierced forms, and other designs of many kinds. Real improvements in the hinges themselves have been effected only since the more modern improvements in iron and steel work generally, — that is, within the last hundred years, or thereabouts.

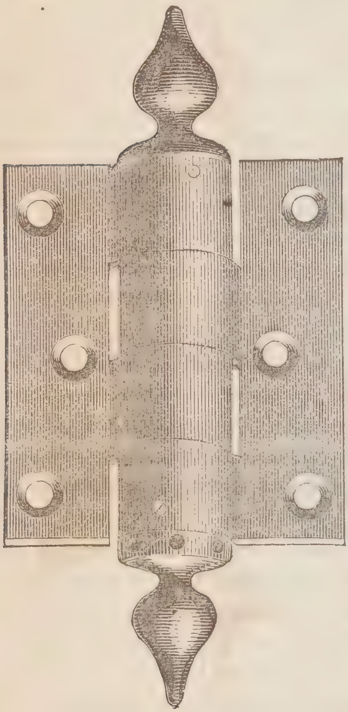
The most significant patents on the subject have, however, been issued both in Europe and America within a much shorter period than this. Some of them are for slopes on the flanges of the hinge, which cause the door to rise a little as it is opened, and, of course, to slide back by its own weight. Others are for combinations of a spring with the hinge, having the same purpose. But until within a few years, the labor-saving idea of making self-closing doors has more usually been effected by means of a separate spring and roller behind the door; by a torsion rod, to be twisted in opening the door, and to shut it by the force of its untwisting; or by the simpler and older means of a counterpoise hung by a line running over a pulley. Of these ideas there have been numerous modifications.

As in so many other cases, it was an American idea which has been developed into the latest and greatest advance in contrivances for perfecting hinges. This idea is embodied in what are called the "American Spiral Spring Butts," and which are manufactured exclusively by the American Spiral Spring Butt Company, 27 Park Row, New York.

A butt, as most people know, is such a hinge as is commonly used for a door. The American Spiral Spring Butt is a combination of spring and hinge, in which the rod or pivot that runs through the alternate cylindrical flanges of the two portions of the common butt is replaced by a cylindrical sheath containing a strong spiral spring. This spring is so placed and fastened that, as the door opens, the spring is forcibly in part uncoiled, by being turned or pushed backward in the direction of the coil. Of course, when the door is left free again, the powerful pressure with which the spring returns to its position drives back that part of the hinge to which it is keyed to the position where it was when the door was shut, and drives the door with it. That is, it shuts the door — the action of the spring moving the hinge, and the hinge carrying the door, just as, in opening, the door had carried the hinge, and the hinge the spring.

The spiral spring butts are made of about thirty different sizes,

from those of only three inches in length, for light baize doors, up to those a foot long, for heavy outer doors, like those of churches and other large buildings. All the sizes, however, are larger and heavier than ordinary butts of the corresponding grade. This is a great advantage, for not only does the greater quantity of metal render the butt much stronger, but its distribution in the different parts of the butt, and particularly in the roomy cylinder formed by the flanges, adds a great further share of strength, and the large surface occupied by the different bearings of the parts of the butt is found to keep them remarkably true during long periods of use. This is an important excellence, as a door that sags either downward or forward from the grinding away of the parts of the hinges upon each other, is liable to jam very inconveniently either upon the threshold or upon the outer door-post.



AMERICAN SPIRAL SPRING BUTT.

Another very desirable quality in these spiral spring butts is their noiselessness. The creaking of ill-oiled hinges is extremely disagreeable; and the same breadth and arrangement of bearings that keep these hinges so true, are also found to make them very silent in working. They are the first practically noiseless metallic hinges that have ever been made.

All these observations relate to butts made on the plan of the common hinge, having two flaps and one cylinder between them, through which passes the pin or pivot. A modification of the American Spiral Spring Butt has, however, been invented, which not only sends the door back to its place after opening, but which allows the door to be opened indifferently to either side, and sends it back equally from each. These are called "double-action butts," and this invention is *the only centre-rest hinge*. The object is

ILLUSTRATIONS.

FIG. 1. Double Action Butt, for swinging doors or gates both ways.
FIG. 2. Top, holding upper end of Spring.
FIG. 3. Spiral Spring, encased in sheet iron cylinder,
FIG. 4. Bottom, holding lower end of Spring.
FIG. 5. Section of single Action Butt.

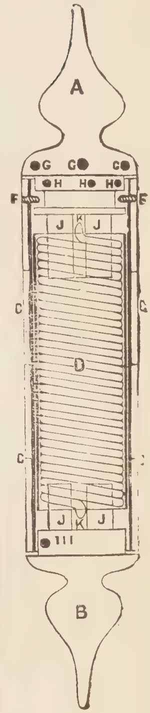
A, Top—B, bottom—C, Flanges—D, Spring.

F. F. Screws which pass through the Flange, C, into the groove of the Top A, securing the latter to the Flange, and also allowing it to revolve.

G. G. G. Holes in Top for receiving the Lever, [Fig. 7,] by which the Spring is adjusted.

FIG. 2.

FIG. 5.



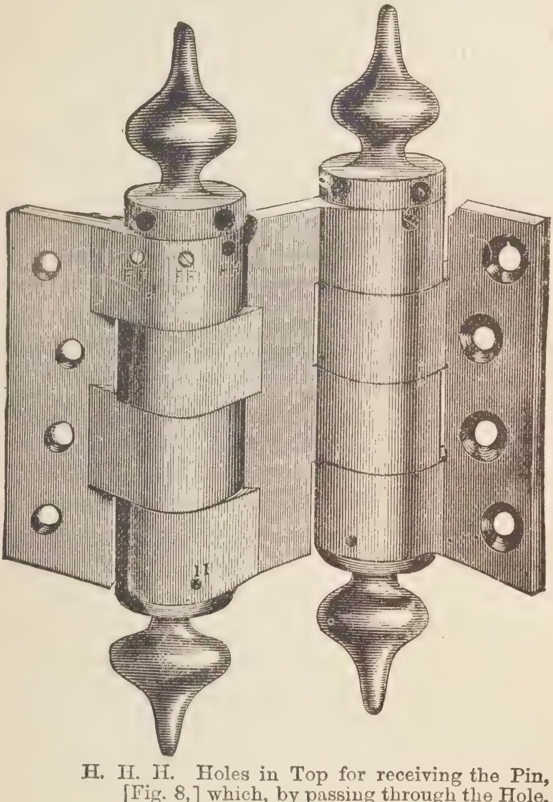


FIG. 1.

FIG. 3.

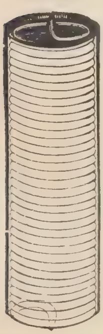


FIG. 4.

H. H. H. Holes in Top for receiving the Pin, [Fig. 8,] which, by passing through the Hole, H. H., on the Flange, secures it to the Top when the Spring is turned up.

I. I. I. Holes through which the Rivet, [Fig. 9,] passes, securing the Bottom to the Flange.

J. J. Jaws of Top and Bottom, clasping ends of Spring.

K. K. Ends of Spring in Jaws, J. J.

FIG. 6. Flanges, showing joints of Butt.

F. F. Screw Holes.

H. H. Pin Hole.

I. I. Rivet Hole.

FIG. 7. Lever for adjusting Spring.
FIG. 8. Pin securing Flange and Top.
FIG. 9. Rievt securing Flange and Bottom.

FIG. 6.

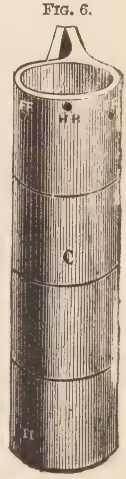


FIG. 7.

FIG. 8.

FIG. 9.

accomplished by giving to each butt, instead of one cylinder with its spring inside, two parallel cylinders, a flap between them having flanges on each cylinder, while beyond the two cylinders are the flaps that screw upon door and door-post respectively. To get at the nature of this arrangement, it is only necessary to imagine a capital Z, which will represent a section of the double-action butt: suppose a cylinder at each of the sharp corners, with a spring tending to shut the upper and lower arms of the Z snug up to the slanting central piece. The door-post in this supposition would have one of the arms fast to it, and the door the other; and it is evident that if the door is opened, for instance, downward, as the Z now stands, the lower arm only of the Z diverges, leaving the slanting part snug up to the upper arm, while if it opens the other way, arm and slanting part diverge together from the upper arm of the Z, which is fast to the door-post.

But this can perhaps be more easily followed from the engraving, in which the letters and figures refer to a very good enumeration of the different pieces of a complete spiral spring butt.

The clearest way to see exactly how this spring operates is to begin with the spring alone. (Fig. 3.) This lies in a close coil, one end of the wire being laid across the middle of the opening at each end of the coil. First, if we take hold of the coil by these two cross-pieces or handles, turning them in opposite directions, the spring can be either coiled tighter, or pushed backwards, as it were, so as to part the different turns of the coil. Next, the same thing can be done by holding the cross-pieces, not with the fingers, but in the jaws of the top and bottom of the butt (Figs. 2, 4), the two parts of the jaws striding the cross-piece, and passing onward into the interior of the coil. Lastly, when the bottom is pinned fast to the flange from one side of the hinge, and the top to that from the other side (Fig. 5), of course the opening and shutting of the two flaps of the hinge do to the coil exactly what the hands alone did at first, or the jaws afterwards when taken in the hands. Opening the door drives the coil back upon itself, or separates the turns of the coil and enlarges its circumference, and the return of the coil, when relieved, to its former state cannot take place except by pushing back the door to its shut position.

In this spiral spring hinge, the place of the pivot is occupied by a cylinder formed by the coil of the spring, together with a thin sheet or tube of metal slipped on over the coil to hold it firm,

to re-enforce and stiffen it for its duty as pivot, and to preserve it from the wear and tear of friction against the interior of the flanges. This sheet or tube is, in fact, the pivot; being a cylinder, however, in place of a solid pin, and having two parts, the outer tube, or sheath, to give it the proper smooth pivot surface, and the inner coil, which exerts the spring power.

If more stiffness is required from one of the spiral spring butts than it possesses when first put up, the rivet (Fig. 8) is taken out of its place H (Figs. 5, 6), the lever (Fig. 7), or a brad-awl, stout wire, or equivalent article, is inserted in one of the holes G (Fig. 5), and the top turned as if the hinge were upon an opening door, that is, against the coil of the screw, until the resistance is as great as required. When this point is reached, the rivet (Fig. 8) is replaced, passing through its former place in the flange, but entering the top of the butt in a new place, and so as to hold the spring in its new position of increased stiffness and strength.

The use of these spring hinges saves an immense number of minute portions of time and effort, and prevents an immense number of inconveniences and irritations from forgetfulness, especially in the case of all doors in constant and severe use, such as the heavily-made doors of large public buildings, those of railroad cars, etc. The great practical value of the spiral spring butts is conclusively proved by the large and constantly increasing number in use, as, for instance, in the Capitol at Washington, in the buildings of the Equitable and New York Life Insurance Companies, the Stock Exchange, the Sub-Treasury, Custom House, the Academy of Design, the Park Bank, not to mention numerous hotels and other public buildings, besides private ones, railroad cars, etc., etc.

Another usual tribute and conclusive testimony to inventive merit has been promptly given in the present case, namely, that of counterfeiting the device, or using it in infringement of the rights of its patentees. So extremely valuable has its use appeared to certain persons interested in some western railways, that they have been attempting to manufacture the same kind of butt in a secret manner; and butts claiming to be those of the American Spiral Spring Butt Company, or else to be on the same principle, but greatly improved, are from time to time put upon the market. It is only genuinely valuable inventions which are liable to such dishonesty as this; just as it is real virtue which is imitated by hypocrites.

FIRE-ARMS.

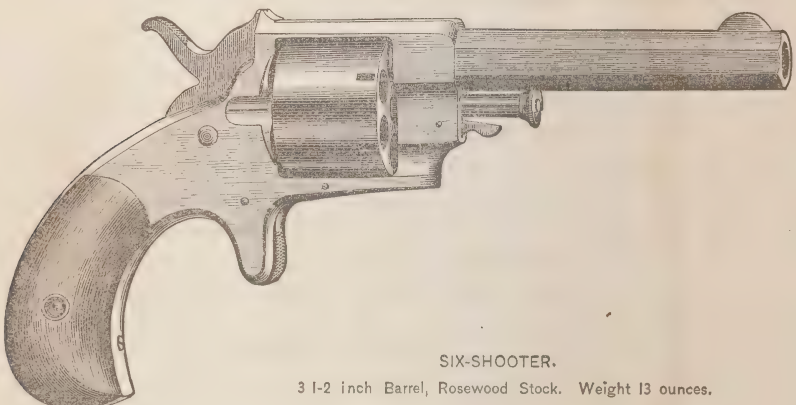
THE IMPROVEMENT IN THE STYLE OF MODERN FIRE-ARMS. — THE NEW METHODS OF THEIR MANUFACTURE. — MESSRS. FOREHAND AND WADSWORTH, THE SUCCESSORS OF ETHAN ALLEN AND CO. — THE PROCESSES USED IN THEIR MANUFACTORY. — SIX-SHOOTING REVOLVERS. — BREECH-LOADING SPORTING RIFLES. — METALLIC CARTRIDGES. — BREECH-LOADING DOUBLE-BARREL SHOT-GUNS. — THE ESTABLISHMENT OF THIS HOUSE. — MR. ETHAN ALLEN. — HIS SUCCESSORS.

THE improvement in the making of fire-arms is one of the most noticeable features of the modern era of industry. The whole fashion and style of our weapons has, within the last half century, undergone a change almost as marked as that in the method of their manufacture. With the application of machinery, the production of fire-arms has been as much cheapened as have been all other articles of consumption to which this method has been applied, while their perfection has also by the same means been made a matter of certainty, and lightness, accuracy, and gracefulness of form made as distinguishing marks of the fire-arms of modern times as the want of them was of the "blunderbuss," the "match-lock," and the "flint-lock," which are now consigned to our museums.

The present results attained in this course of improvement will be most easily displayed by a description of the methods used in the manufacture of fire-arms by Messrs. Forehand & Wadsworth, of Worcester, Mass. These gentlemen are the successors of the firm of Ethan Allen & Co., the chief partner of whom, Mr. Ethan Allen, is well known for the success which attended his efforts in introducing the improvements for which the modern styles of fire-arms are distinguished.

To commence with the barrels. These are made of the best

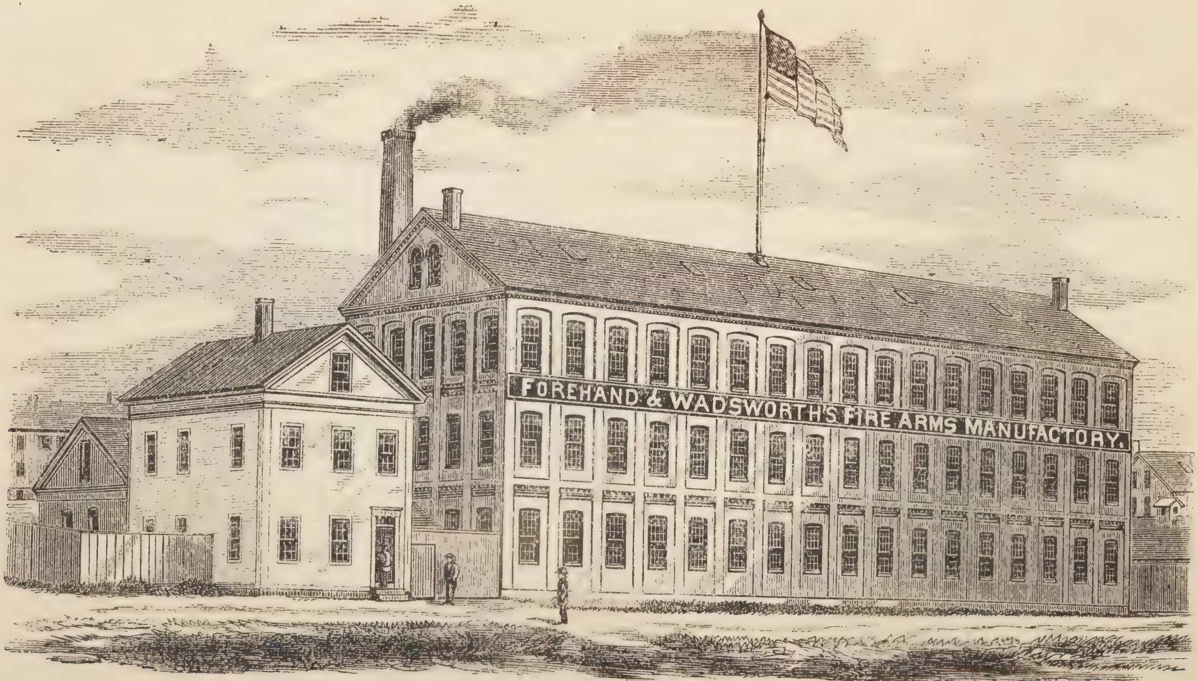
English decarbonized steel, which comes worked into bars, usually of a round form. The barrels being cut off the right length, are then drilled and reamed to the proper size of the bore, and then milled to the required size and form. With the repeating fire-arms, the cylinders are then drilled and reamed as the barrels were, and the chambers, six or seven in number, are then drilled. This operation requires the most skilful workmanship, no deviation from the most exact resemblance to the pattern being allowable. The chambers must be precisely parallel with each other, and must be perfectly adjusted with reference to the ratchets by which the cylinder is made to revolve, so that they are presented in an absolutely right line with the barrel on the discharge of the cartridge, since, if this is not the case, the ball is either split or shaved as it passes into the barrel, or the pistol is broken, as sometimes happens with those which are made without sufficient accuracy of workmanship.



SIX-SHOOTER.
3 1-2 inch Barrel, Rosewood Stock. Weight 13 ounces.

For the construction of the cylinder, Mr. Ethan Allen invented several machines, which added greatly to the production of pistols, as well as secured greater accuracy in their details, and durability of the whole instrument. Among these machines is one, which is exclusively used in the establishment of his successors, who control the patent, and by which the production of cylinders is lessened by several per cent., while making them more valuable.

The "milling out," or filing out of the ratchets of the cylinders, in the way used by other manufacturers of fire-arms, is a slow



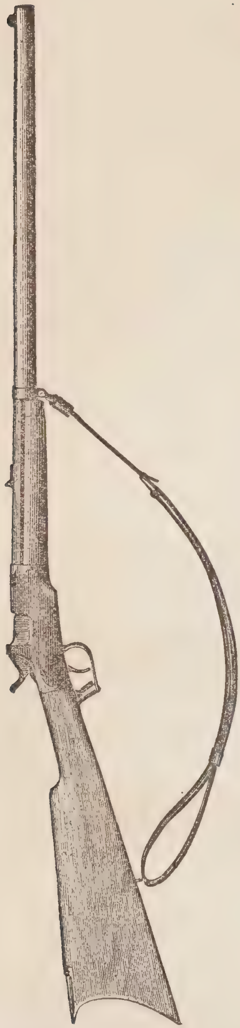
FIRE ARMS MANUFACTORY, FOREHAND & WADSWORTH, WORCESTER, MASS.

process, and not always accurate. For this operation Mr. Allen invented a machine by which the ratchet is formed by pressure, or indenting the steel under the combined force of a lever and a screw. By this at least six hundred per cent. more ratchets can be made in a given time than by the methods used elsewhere, while by compression the steel is hardened, so that a ratchet made by this method never wears away.

The frame of the pistol or revolver, which includes the portion in which the handle is set, and in which the cylinder moves, is by Messrs. Forehand & Wadsworth forged from the best Norway iron. Forged frames are much better, being stronger than those made from cast iron, as they are generally manufactured, there being, we believe, only one other manufactory of fire-arms in the country where the frames are made of wrought iron. The frames are forged hot, under dies, and all the parts of the pistol, except the handle, are made of wrought iron and steel.

After the frame is forged, it undergoes the milling process, by which the recess, or place for the lock, is cut out of the solid metal, and the other portions of the frame cut to the proper size and shape, the contour and outer surfaces being "edged" upon a machine, that is given their proper lines and angles. A great advantage possessed by the pistols made in the Ethan Allen & Co.'s works is, that the exploded shells can be removed without removing the cylinder. The frame is whole, or fixed, not moving on a hinge. Weapons of this kind are made very strong and durable, weighing only from six to thirteen ounces, and are beautifully finished. Single-shot cartridge pistols, of the Derringer pattern, and other small cartridge pistols, are also made in large quantities by this house.

The Allen breech-loading sporting rifle, which must not be confounded with the Allen military breech-loader, is also largely manufactured by this establishment, and is in great demand among sportsmen. This weapon was also invented by Mr. Allen, and was the first breech-loading arm made for the use of the metallic cartridge, the cartridge before having been made of paper. The metallic cartridge is a French invention of about 1831, and was introduced into this country shortly after. Some improvements upon it have been invented here, and the method for its manufacture has also been improved, and chiefly by Ethan Allen & Co., Mr. Allen having patented machinery of his own invention for this purpose, which



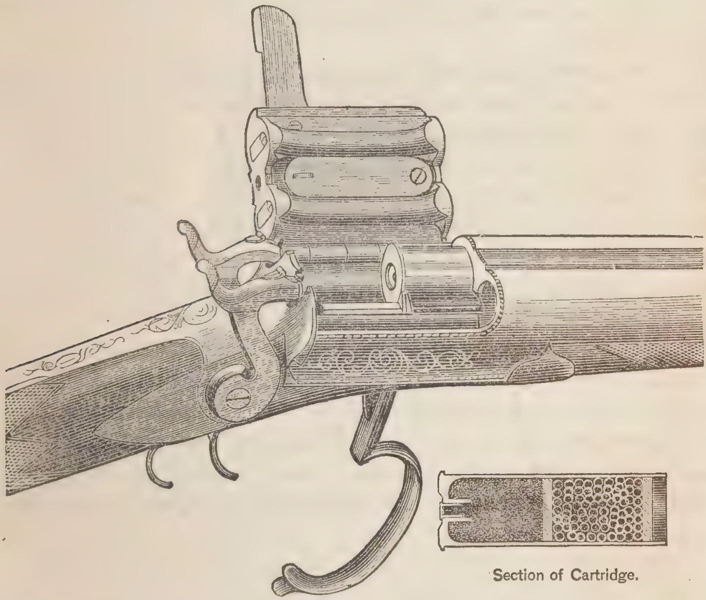
BREECH-LOADING SPORTING RIFLE, of various Calibres, from 22 to 44 hundredths.

is now used in a measure by every one engaged in making them. The chief advantage of the Allen breech-loader is the facility with which it is operated, the opening and closing in charging it, and the security of the breech-block, which prevents any accidental discharge of the cartridge. The material and workmanship of this breech-loader are the best possible, and perhaps the best test of its excellence is, that it is in larger demand than any arm of the kind in use.

The breech-loading double-barrel shot-gun, manufactured by Ethan Allen & Co., also demands mention. The peculiarity of this arm, which distinguishes it from all other breech-loading shot-guns, is, that the barrels are stationary, and do not tilt; that is, that the barrels are stationary, and not connected with the stock by a hinge at or near the breech, but are fixed, like those of muzzle-loading guns. The breech, which is hinged on the side, is made with a chamber, in which the cartridge or charge is placed, and a cap, and is prepared for receiving the charge by lifting the cap, as is shown in the accompanying engraving, which shows also the cartridge partly withdrawn from the chamber after explosion.

It will be noticed that in the engraving the guard is represented as thrown forward. This shows the manner in which the cartridge is withdrawn from the barrels, a lever being attached to the guard, which, when thrown forward, acts on the cartridge shell, and forces it from the chamber. When the lid is down, it is held firmly in place by a lock, operated by an extension lever, which can be manipulated instantly. This arm can be loaded, or the cartridge withdrawn, with the greatest rapidity, and is the most secure arm made, being liable to no accident. The breech

lever cannot be opened for receiving the cartridge until the hammers are placed in the safety-notch. These guns are made of various sizes, varying in weight from seven and a half to twelve pounds. Either paper or metallic shells can be used with this gun, and with either its mechanism is such that no gas escapes, on the explosion, into the rear chamber. Both paper and metallic shells accompany the gun. .The barrels are made of laminated steel, Damascus steel, and of "fine stub and twist," of the best quality.



Section of Cartridge.

BREECH-LOADING DOUBLE-BARRELLED SHOT-GUN, PREPARED FOR LOADING.

These are also made at this establishment, and the process of their manufacture, from the mixing of the metals to the twisting in their various forms and welding, is one of the most interesting features in the whole construction of the arm. Until quite recently all barrels of the better qualities for shot-guns were brought from Europe. The secret of manufacturing the metal, so as to produce the various figures, was not known to the American manufacturers of arms; but this firm set themselves at work to discover the process, and were soon rewarded by being able to produce as fine a quality of barrels of various figures as were ever brought from Europe, and they claim the credit of being the

first manufacturers in the United States who were able to make "laminated," or "Damascus," barrels.

This house was established in 1835 by the late Ethan Allen, a man of great mechanical genius as well as force of character. Mr. Allen invented not only many new forms of fire-arms and modes of operating them, but also several machines of great importance in their manufacture. He was a gentleman of untiring industry, and gave his best energies to his business, carrying it successfully through the financial crises of 1837 and 1857, and at his death, in 1871, leaving a large estate as the result of his successful labors.

The business he had built up passed to the hands of his sons-in-law, Messrs. Forehand and Wadsworth, who had been connected with him for many years in conducting it. These gentlemen are now the sole proprietors of the establishment, which is one of the best appointed manufactories in the country. That they duly profited by the instructions of Mr. Allen, and are worthy successors of the house for which his talents had won a world-wide reputation, is shown in the fact that since the death of Mr. Allen, although so recent, yet they have added to the productive capacity of the establishment by new and improved machinery, as well as by new devices for arms, of a very important nature. Every part of a pistol or gun is manufactured in this establishment, it being wholly independent of any outside aid for any portion of their work. The electro-plating of their work, as well as the chasing and engraving, is done in the establishment by the most skilful workmen.

LATEST IMPROVEMENTS IN THE UTILIZATION OF STEAM.

THE HISTORY OF INVENTION. — THE NECESSITY FOR IMPROVEMENT. — THE LAW GOVERNING IT. — ANALOGIES FROM NATURE. — THE HISTORY OF THE STEAM ENGINE. — THE CHIEF POINTS IN THE UTILIZATION OF STEAM. — THE TEST OF INDICATOR DIAGRAMS. — A DESCRIPTION OF THE PROCESS. — THE APPLICATION OF THIS TEST TO THE BABCOCK AND WILCOX ENGINE. — THE CAUSES OF ITS SUPERIORITY. — THE STEAM JACKET. — THE COURSE OF THE IMPROVEMENT OF THIS ENGINE. — THE DIFFICULTIES TO BE OVERCOME. — THE WORKINGS OF THE ENGINE. — ITS CONSUMPTION OF FUEL. — THE TUBULOUS BOILER. — ITS MERITS. — ITS CONSTRUCTION. — THE PREMIUM OF THE AMERICAN INSTITUTE. — THE STATEMENT OF THE JUDGES.

In the history of invention, as in the history of any other department of human energy, the student is struck with the fact that it is only by repeated improvements and modifications that ultimate perfection is reached. From the inception of the first idea up to its subsequent adaptation to practical use, the varying conditions require varying modifications to reach the new necessities of the case.

With the increasing experience of mankind, new demands are created, and our conceptions of perfection are constantly advancing. The raft gives place to the canoe, which in turn yields its place to the galley, to be replaced by the sail ship, which is finally supplanted by the steam ship. Nor is it only in mechanical appliances that this course of improvement is pursued. The theories of one age are found inadequate to supply the necessities arising in the next from an increase of knowledge gained by a widened experience.

This need of innovation, as an evidence of the spirit of improvement, has, however, only in quite modern times been discovered to be a law of nature; and man, in his own domain of intellectual development, must of necessity follow the same course of

evolution which Nature herself has followed in the production of the, at present, diversified variety of her organized beings. It is by modifications to suit the changing conditions that the clumsy monsters of the primeval world have been replaced by the more symmetrical and agile creatures of to-day.

Nor does this law hold with less force in man's own connection with Nature; and the influence of his own intelligence in this domain we see constantly exemplified on every hand. It is thus that most of our vegetables have been produced, that the potato has been made an esculent from the bitter root it was in its natural habitat. It is thus that our domestic animals have been produced, and that man has obtained, in civilization, that knowledge and control of the forces of Nature which divide a portion of the earth's inhabitants to-day from the periods of barbarism out of which they have emerged.

When considered from this point of view, the study of any single branch of the advance of human society along the path of evolution or progress, however inconsiderable it may at first appear, becomes valuable as affording an indication of the laws of growth, and as giving a suggestion of the method which must be observed for the scientific study of all social advance.

The history of the steam engine is a record of the slow steps by which it has been perfected, and the opposition which the industrial conservatism of the times and the prejudices of vested rights in certain methods of manufacture have constantly offered to the acceptance of every suggested improvement; and is in a smaller degree a counterpart of the larger history of the world's progress.

With the first machines for utilizing the energy of steam, the appliances were of the rudest description. Little or no attention was given to economies, and perhaps even less to symmetry of design, which now are the subjects to which the most study is given. There was not then the necessity that there is now for such study, nor was there the knowledge in the world to make it. Now, however, that modern industry depends chiefly upon steam for the force it needs, the attention of the builders of steam engines has been turned chiefly to perfecting the utilization of steam, in order to satisfy the inexorable demands for economy, necessitated by the greater activity of the industrial life of to-day.

In this course of improvement there have been various styles of engines produced, varying as greatly in their merits, as their

methods of construction differed. But it has been only by such practical trials that the knowledge has been gained by which a scientific examination of the relative values of engines of different models could be made, and that a scientific conception of the steam engine itself has been arrived at.

The chief points in which the utilization of steam consists are evidently in the expense of the fuel necessary in its generation, that is, in the construction of the boiler; and then in the appliances by which the steam is enabled to do its work in the engine itself. In the Babcock and Wilcox engine, manufactured by the Hope Iron Works, of Providence, R. I., the improvements introduced have secured a perfection in these respects which is probably as great as it is possible to attain with present knowledge.

The test of the efficacy of an engine is best made by the "indicator diagrams," by which the action of the steam within the cylinder, the time and rapidity of its entrance, the point of cut-off, its action in expanding, the time of release, the amount of back pressure, compression, and so on, are indicated. This is done by an instrument worked by the pressure of the steam and the motion of the piston. These two motions, acting at right angles, produce a curve which indicates the exact pressure of the steam at each portion of the stroke.

By this instrument this curve is drawn, and the line thus made during a complete revolution of the engine encloses an irregular figure, the shape of which varies with every different condition in the elements which form it; and by its configuration can be determined, not only the actual power exerted by the steam, but also the relative perfection of the valve motion, and the effect of different proportions between the piston and the passages.

This method of judging of the action of a steam engine has been known since the time of Watt; but it is only within a very few years that an instrument has been invented sufficiently accurate to justify any confidence in its indications when attached to the rapidly-working engines now in use. Since its invention, however, all scientific engineers have recognized its value, and to its use the world is indebted for the most satisfactory practical knowledge of the action of steam, and of the best means for obtaining the highest economical results in its use.

In order to compare, by the use of the indicator, the action of one steam engine with another, they should be both placed in exactly the same circumstances. As, however, it is almost impossi-

ble to ever realize this, the same result has been arrived at by selecting a standard to which the action of engines to be tested may be compared, and thus their relative value arrived at. This standard has been made, for every engine, the results which would be produced by a theoretically perfect engine of the same capacity under the same circumstances; and the engine which more nearly approximates this standard is of course considered to more nearly approach the perfect engine.

Proved by this test, the Babcock and Wilcox engine has shown a utilization of ninety-five and nine-tenths per cent. in the cylinder — a result higher than has been reached by any other engine, the best never exceeding seventy-seven per cent.

It is manifestly impossible to construct an engine in which there shall be no loss from the friction of the steam in the pipes and passages, or from the clearances; but the nearest approach which has yet been made to it is shown in the indicator diagrams made from the Babcock and Wilcox engines.

This result is due to the superior mechanism and the arrangement of these engines. In the first place the cylinder is surrounded by a steam jacket, in which a constant circulation of live steam is kept up, thus keeping the cylinder nearly up to the point of boiler pressure, and preventing any condensation of steam in it.

The steam jacket was suggested by Watt, and was used by him in some cases, but has since his time fallen into general neglect, though the admirable effects of its use were known. One of the chief reasons for this has been the difficulty of making it properly. To cast the cylinder and the jacket together requires very great mechanical skill, and it has therefore not been practised. With the Hope Iron Works, however, their appliances and experience enable them to do this successfully, and the results have justified the theoretical conclusions concerning the advantages of keeping the cylinder surrounded always with live steam.

There has also been a prejudice against the use of the steam jacket in the minds of those engineers who have supposed that such an arrangement would cost a loss of power by radiation; but the practical test has shown that this is a mistake, since the saving of power gained by its use has, from scientifically conducted tests, been estimated as equal to ten per cent., often more.

In carrying the improvements of the Babcock and Wilcox engines to a practical result, there have been great difficulties to overcome. As it requires in its construction many new appliances, which should be conscientious and thorough in their workmanship, at first the reputation of the engine suffered at the hands of those who undertook its manufacture, and did not, either from incompetence or ignorance, perform the work as excellently as it should be done. Besides, too, in the introduction of any novelty in machinery, it is most difficult to attain perfection from the first. Experiments have to be made, and it is only by trials that the best methods for arriving at the proposed ends can be found. Nor can it be certainly known from the first what it is most desirable to propose to do.

The theoretic aim in the steam engine is of course to produce the engine which will utilize the energy of steam with the least loss; but in attaining this end, the various appliances necessary, and the numerous questions which arise concerning the adaptation of the parts, and their combination, with the comparative merits of each, render it impossible to decide without experiment exactly how the engine should be built to attain the utmost possible degree of perfection.

The improvement of most machinery is a process of growth, and as with most of the results of human labor, it is by steps only that perfection is reached. In bringing the Babcock and Wilcox engine to its present condition, it has been necessary to meet these difficulties, and to overcome them step by step; but the experience of years has become finally embodied in its present arrangements, and in this course of improvement the engine has been really remodelled.

At present four valves are used in place of one, as formerly; all the working parts are exposed to view, and immediately accessible for adjustment. The component parts of the engine have been so reduced in number that its construction has been made perfectly simple, and its action so regular as to avoid all unevenness of wear.

The valves are so arranged that they can be easily and quickly removed for examination, if desired. The form of the bed gratifies the requirements of elegance of design, while it is sufficiently solid and stiff. In the balance-wheel the forms of the spokes and the other portions have been so designed as to offer the least resistance to the air, and to move through it without commotion,

instead of driving it like a fan; and the result has been a saving of power which has been estimated at five per cent., compared with some other forms in use.

Other various improvements, whose value has been shown by experience, have been adopted in this engine. The pistons, piston-rods, and valve-stems are steam packed; the oilers are self-acting; the connecting-rods are of steel; and other well-known improved methods of construction are found here.

In the construction of these engines, it is also a rule to make all the important parts larger than the proportions usually given them, so that in cases of necessity there is no danger to be feared in driving the engine at a higher pressure of steam or greater power than it is rated at.

In addition to these practical merits, the elegance of design which is displayed in the Babcock and Wilcox engines, together with the perfection of their mechanical finish, is a fitting compliment to their scientific construction, and gives them even a further beauty than that which lies in use.

The form selected for the valves in these engines is the flat slide valves, which experience has demonstrated is the best for wearing "tight," and thus avoiding all leaking. The ports of this engine are large and open, forming in this respect a feature which is peculiar to the engines of this make. By this improvement the steam is never "wire-drawn," as is commonly the case where the steam is cramped in its passage into the cylinder, and much of its energy thus lost, especially when the ports are only partially open. In this engine the ports are always wide open when admitting steam, without regard to the point of cut-off, and when the time for closing them arrives, they close with lightning-like rapidity.

Usually the ports are opened more or less according to the amount of steam to be admitted, which interferes with the free passage of the steam, producing the effect known technically as "wire-drawing;" but in the Babcock and Wilcox engine the action of the parts avoids this fault, and admits the steam to the cylinder, at or nearly at boiler pressure, regardless of the greater or less quantity it is desirable to admit, thus avoiding in every case the loss of any portion of the energy of the steam by its premature condensation. By this means the Babcock and Wilcox engines, which are now in use, work the steam in the cylinder within one or two pounds of the pressure in the boiler — a result wholly unexampled in the history of the steam engine.

This loss of a pound is caused by the friction which the steam must of necessity undergo in its passage through the pipes. In the important matter of the economy of fuel, which is one of the chief considerations in the practical use of the steam engine, the Babcock and Wilcox engine attains better results than have been reached by those of any other make.

At the fair of the American Institute, held in 1869, the award of the first premium was given by the judges to the Babcock and Wilcox engine. In answer to the dissatisfaction with the award, which is usual in such cases, the judges made a statement of their reasons for their action, which will be found in the *Scientific American* for January, 1870. From this we have the space for only the following extract. After giving a detailed account of the entire trial, the statement concludes : "With these facts before them, the judges had no difficulty in deciding which was the *best engine*, and they plainly indicated that opinion by awarding the first premium to the Babcock and Wilcox engine 'for the *most perfect automatic expansive valve gearing*,' supposing that the engineering world, at least, would know that this embodied all the difference in the principle of construction of the engines in competition."

Besides the improvements in the working parts of these engines, the style of boiler employed with them deserves notice. This boiler is a tubulous one. It is neither a radical departure from the forms established by practice, nor a mere variation from them for the sake of novelty ; but it has been designed so as to combine all the correct principles of construction and operation which science and experience have decided are essential to the highest efficiency, economy, and safety.

THE BABCOCK AND WILCOX BOILER.

The manufacturers claim that this is the most perfect steam boiler yet devised, upon the following grounds : It is simple in construction, and is made of the best materials ; it maintains a constant and thorough circulation of the water through it, so as to keep all parts of it at the same temperature ; it is provided with a mud-drum, which receives all the impurities of the water, and is so placed as to be free from the action of the fire ; its combustion chamber is so arranged that the burning of the gases, commenced in the furnace, is completed before they escape through the chim-

ney; while the heating surface is arranged so nearly at right angles to the current of heated gases as to break up the currents, and extract from them all the available heat. In the tubes sufficient water surface is constantly kept, so as to provide for the disengagement of the steam from the water, and thus make all "foaming" impossible; while at the same time not less than two cubic feet of water capacity for each horse power is constantly preserved, so as effectually to prevent any sudden fluctuation in the water level. The space occupied by the water is divided into sections, so that, should any one part give out, there is no single body of water to rush upon the overheated iron, and flashing into steam, produce the destructive explosions so frequent where this arrangement does not prevail. Finally, these boilers have a great excess of strength over any required strain, so that they are not liable to be strained by any unequal expansion, and all their parts are so arranged as to be easily and readily accessible for cleaning and repair.

These boilers are constructed of lap-welded iron tubes, connected with T heads. They are placed in an inclined position, and "staggered," that is, placed in tiers, so that one row comes over the spaces of the row below. A horizontal steam and water drum is provided above, and a mud-drum at the lower end. The fire is made under the higher end of the tubes, and the products of combustion pass out between the tubes into a combustion chamber under the steam and water drum; from thence they pass down across the tubes, then up again, and into the chimney. The water is fed in at one end of the mud-drum, with "blow-off" at the other, while the steam is drawn off from the top of the steam drum, near the back end of the boiler.

By this arrangement a constant circulation is secured, by which every particle of steam is taken away as soon as formed, and its place supplied with a particle of water, while the circulation keeps up an equal temperature all through the water, preventing any strain upon one part, and besides, preventing in a great measure any incrustation upon the heated portions of the tubes.

The perfect combustion and thorough absorption of the heat causes the economic use of fuel, which has been before referred to, while by the circulation, and the large disengaging surface obtained by its method of construction, the steam is obtained perfectly dry, even when the boiler is forced to its utmost capacity. This method of construction affords also other incidental advan-

tages, among which may be mentioned the ease with which access is had to any part of it. While the capacity of the boiler is as great as that of any other, the space occupied by it and its setting is much less ; and further, the ease of transportation, the parts being so readily separated and put together again, makes it very desirable for shipment, especially as any of the parts can be easily handled by one man.

ARCHITECTURAL IRON WORK.

RECENT USE OF IRON IN ARCHITECTURE. — BRIDGE OF CAST IRON IN 1773. — FIRST CAST IRON BEAMS IN 1801. — TUBULAR BRIDGES. — FIRST CAST IRON BUILDINGS. — SENTIMENTAL OPPOSITION TO IRON BUILDINGS. — GREAT ADVANTAGES OF IRON AS A BUILDING MATERIAL. — IRON WORKS OF MESSRS. BARTLETT, ROBBINS, AND CO., AT BALTIMORE. — THE CAST IRON DOG. — BEGINNING AND GROWTH OF THE FIRM. — EXTENT OF THEIR BUSINESS. — DURABILITY OF THEIR HOT-WATER WARMING APPARATUS. — ACCOUNT OF THE DEPARTMENTS OF THEIR WORKS. — HOUSES AS FURNISHED AND FITTED BY THE FIRM. — CAPABILITIES OF IRON FOR BEAUTY.

Among all the innumerable uses of iron, the architectural has been one of the latest. It has been used for nails, bolts, locks, hinges, and fastenings, and fixtures of every kind, as well as for railings, gratings, and, save details, for exterior finish and ornament. But iron houses are of very recent date.

Bridges were made of iron before houses or ships, a cast iron bridge of a single arch having been thrown across the Severn River at Colebrookdale about 1773, or a little later. The idea of this bridge originated with one Thomas F. Pritchard, an architect, and it was put up by Mr. John Wilkinson, iron-master.

The use of iron in house building began with the introduction of cast iron beams in fire-proof buildings. The first of these were designed by the celebrated firm of Boulton & Watt, for a fire-proof cotton mill, built at Manchester in 1801, for Messrs. Phillips & Lee; and the wonderful genius of Watt enabled him, as if by intuition, at a period when the positive knowledge required actually did not exist, to make " a tolerably correct approximation to the true proportion of the parts of the beam, so as to secure a maximum strength with a given quantity of material."

This mill was the model for similar buildings, until by Mr. Hodgkinson's experiments on the strength of iron beams at Manchester, in 1827, and subsequently, the proper size and shape of cast iron beams were scientifically calculated and determined. Wrought

iron beams were not used until some time later. By the year 1840, or before, both columns and beams of iron were commonly used in fire-proof factories and other large edifices. The first iron ships were built in 1835. The experiments made in 1845–6 on the construction of tubular bridges and beams, preparatory to the erection of the celebrated Britannia Bridge over Menai Strait, considerably increased the amount of positive scientific knowledge of the architectural capacities of wrought iron.

The erection of cast iron buildings was first attempted in New York about 1840 or 1845, but it was a considerable time before either American or English capitalists could be induced to invest in the business. The discovery of gold in California, however, quickly established it, for it was found that the American cast iron buildings shipped thither could be put up in a day, while the wrought iron houses sent from England required a month, and it is needless to add that there was an immediate and remunerative demand for them. According to some traveller, the Americans "require that everything should be done in not over twenty minutes," and it is no wonder that this thirty-fold superiority in point of time was appreciated in California, which was in those days, if it is not now, the fastest portion, in a business point of view, of the United States.

The first iron building in New York was put up about the same time, the authorities consenting only with extreme reluctance, for the reason that, as they alleged, in case of fire it would "burst" in such a manner as to be extremely dangerous to the firemen. From that time, however, the use of both cast iron and wrought iron for building purposes has greatly extended, and is increasing more and more rapidly, although at the same time this use for it is unquestionably only in its infancy.

A certain class of architects are disposed to object to iron in architecture for sentimental reasons, mostly such as will be found in the works of Mr. John Ruskin. They say, substantially, that it is not proper, and, indeed, that it is sinful, to imitate in one material forms used in another; that it is wrong to put iron, for instance, into forms suitable for marble or granite. The trouble with this sentimental school of criticism is that it wants a scientific method for criticism quite as much as those it criticises want the same method in their treatment of iron as an architectural material. In regard to churches, in particular, it is said that iron structures of this kind are too cheap, too transient, and too inex-

pressive of religious sentiments. It seems singular that our architects should not have recognized that iron is a legitimate building material, but should be used legitimately, especially when the Crystal Palace has afforded so notable an instance of its value and right use. In this country, at present, the fact that a building material is cheap, handy, strong, safe, and easily movable, will not readily be opposed by any other consideration, and finally increasing culture will lead to its scientific use.

The truth is, that the list of advantages for building purposes which iron presents, is very remarkable. Its strength to bear weight is, for equal areas, ten or eleven times as great as the harder granites or marbles, twenty times as great as white oak, forty times as great as freestone (or "brown stone"), nearly two hundred times as great as ordinary brick work. Its tensile strength makes it fit also to be used in slender pillars and thin sheets, and to be so distributed as to leave an unprecedented proportion of space for windows, while it wastes a correspondingly small proportion for thickness of wall. The combinations of casting and forging make its capability of receiving forms absolutely unlimited, and at the same time facilitate the exact multiplication of parts to any extent. But it will be sufficient to quote an abridgment of the nine reasons for the use of iron in buildings, not long ago stated in a paper presented to the American Institute: —

1. Great facility in embodying any architectural design.
2. Great economy of wall space.
3. Economy in cost of foundations.
4. Economy and facility of moving and re-erecting.
5. Security against lightning.
6. Ease of ventilation.
7. Imperviousness of material, saving contents from damp, decay, etc.
8. Durability of material.
9. Incombustibility.

It is not, however, intended in this place to attempt any detailed exposition of the merits of iron as an architectural material. Those merits are already extensively recognized among scientific men, and are rapidly gaining reputation with all classes. What is here meant is mainly to show, by some account of one of the largest and best established architectural iron works in the United States, — that of Messrs. Bartlett, Robbins, & Co., of Baltimore, — how complete and fully fitted a house can be turned out from one concern.

The whole description by which the business of this firm is ordinarily set forth, will suggest something of the breadth and variety of its industrial activity. "Manufacturers," the phrase is, "of architectural and ornamental iron work, stoves, ranges, and heating apparatus." This includes outside, inside, comfort, and decoration; and after going through their extensive works, and examining the immense variety of their stock, patterns, and designs, the visitor would really hardly be surprised to find departments for turning out iron carpets and iron feather beds, iron wall paper, and iron pictures. Iron statues they do make. They have furnished a good many copies of a gigantic cast iron Newfoundland dog, one of which is usually on guard at the door of their store in Light Street, and which is a delusion and a snare to all the dogs that pass by. Once, at least, he even deceived a human being. A gentleman, a friend of the partners, told them one morning that late the night before, and much absorbed in some business thoughts, he was passing their store door, when the sudden view of this gigantic dog standing up there, with a vast black muzzle, within an inch or two of his person, startled him so that he sprang out half across the street before he remembered that it was a cast iron beast.

The firm now so widely known as Bartlett, Robbins & Co., began business as Hayward, Bartlett & Co., in the year 1844, as a stove foundry. The manufacture of railing, and other ornamental iron work, was soon added. Next came the architectural department proper; and then further special departments for galvanized iron, for vault lights, and for heating apparatus by high-pressure steam, by low-pressure steam, and — which is believed to be decidedly a cheaper and more satisfactory plan than either — by hot water.

For several years, beginning with 1863, the firm also conducted the whole vast business of the Winans Locomotive Works, and during this period the extent and responsibility of their business operations may be inferred from the fact that their usual pay-rolls were about one thousand dollars a day. This part of the business has, however, been dropped, the remainder of it having grown to dimensions sufficient to satisfy any ordinary ambition. A great number of first-class iron buildings erected by them, are to be found in many parts of the city of Baltimore, and many others are standing as monuments of their mechanical skill in New York and other cities, while they have filled, and are constantly filling, im-

portant contracts in all the branches of their business in the principal cities of the United States, from one end of the country to the other. Their heating apparatus, for instance, is employed in the state house at Richmond, in the treasury building at Washington, in the United States custom houses, or other large public edifices, at Portland, New York, Buffalo, Cleveland, Cincinnati, Indianapolis, Chicago, etc., etc., besides numerous private residences. The oldest heating apparatuses put in by the firm have now been in use about fifteen years, and are still working perfectly, and with only trifling cost or delay for repairs. It is an interesting fact that the water with which every part of the hot-water apparatus for warming buildings is filled, preserves the pipes from rust, and its waste from evaporation is so trifling that, although the circuit of single systems of pipe has been as much as half a mile, a pail or two of water daily keeps the whole full. Working with not over 200° F. at the boiler, and supplied from an open reservoir, there can be no danger of fire or explosion, and the low temperature of the radiating surfaces insures a quality of air as much superior to steam or hot-air furnaces as the difference in the temperature of their surfaces.

We give an extract from a characteristic letter of the firm, written in reply to inquiries respecting their hot-water fixture. This letter illustrates the entire faith they feel in their own work, and also shows a sort of pride with regard to what is called "puffing" in general, that is not so universal, perhaps, as some other good qualities: —

"We do not run this as a hobby, and do not desire to overrate the apparatus, having always preferred inviting investigation of fixtures, tested by long use, in preference to publishing.

"They have been used in most exposed positions, and left to the tender mercies of officials, constantly changing, many seemingly anxious to condemn what is in, to make a job for friends. . . . How long they will last we are not yet able to say, as we think all we have ever made are still in use. Some of the largest have been in use twelve to fifteen years, with very trifling repairs. . . . The reply to the only objection that can be made to them, — their first cost, — is, that they last so much longer, and consume so much less fuel than any other, that they are really cheaper."

The extensive foundry and workshops of Messrs. Bartlett, Robbins & Co. occupy three squares of ground in the southern part of

BARTLETT, ROBBINS & CO'S ARCHITECTURAL IRON WORKS, BALTIMORE, MD.

sult the series of lithographs, wood cuts, and photographs laid before us, and ask any additional questions, we find that the firm can make for us a house, all complete, with walls, floors, doors, windows, roof, verandas, and balconies, cornices, and external ornaments of many kinds, vaults, and vault lights, ventilators, with fences and gates, ornamental fountains, summer house, vases, statuary, and garden seats, chairs or settees, gas and water fixtures, a heating apparatus, and either kitchener, range, or cooking stove, as required, parlor stoves or grates of any kind, ornamental brackets for shelving, hitching posts, and stable fixtures, such as mangers, rack, partitions, etc., drain pipe, iron pavements, bath tubs, and plumbers' castings, and pipe of all kinds. Cast iron pots and kettles, and culinary implements of all kinds, go with the stove. Bedsteads of cast iron or wrought iron, or both, can also be furnished. In fact, in case of strict necessity, the firm of Bartlett, Robbins & Co. could turn out a dwelling which, with the addition of the necessary textile fabrics, would be surprisingly near to complete readiness for its inmates.

The great capabilities of iron for beautiful forms are well shown in its use for architectural purposes, as its strength makes it suitable for structures and tracery of a light and graceful effect altogether beyond what is possible in wood or stone. In it can be rendered both the simpler and the richer beauties of the Greek orders, the characteristic arches and stratifications of Rome, the points and pinnacles of Gothic design, and the traceries and arabesques, domes and pinnacles, of the Moors. Some of the combinations produced by a union of light castings and wire or rod work in trellises and verandas are wonderfully rich and light in effect.

Both Mr. Bartlett and Mr. Robbins are of New England birth, and have been wholly the architects of their own fortunes. Mr. Bartlett's training was on the mechanical side of the business, and Mr. Robbins's was chiefly financial; so that they are fortunately associated for the requirements of so extensive a concern.

BANK NOTE ENGRAVING.

COMPARISONS. — AMERICAN AND FOREIGN BANK NOTE ENGRAVING. — THE BANK OF ENGLAND. — ENGRAVING ON THE CONTINENT. — THE ART IN AMERICA. — THE PIONEER IN THE PROCESS. — INVENTION OF TRANSFERS. — SECURITIES AGAINST COUNTERFEITERS. — LATHE AND OTHER MACHINE WORK. — THE DEMAND FOR BANK NOTES. — COMBINATION OF COMPANIES. — THE AMERICAN BANK-NOTE COMPANY. — PRESENT PROCESSES OF ENGRAVING AND PRINTING. — ADVANTAGES OF THE TRANSFERS. — HOW THE PLATES ARE PREPARED AND PRINTED FROM. — PRESSES WHICH DETECT THEFT. — MACHINES WHICH COUNT. — THE FIRST GREENBACKS. — NATIONAL BANK NOTES. — THE FINEST SPECIMENS IN THE WORLD.

The earlier specimens of bank note engraving, as compared with the elaborate and artistic productions of the present day, were crude and rude indeed. Between the Continental notes of the Revolution and the government issues of to-day, and even between the bank notes of fifty years ago and the present national bank bills, there is almost as great a contrast as there is between the "block-books" of the fifteenth century and the finest typographical efforts of the nineteenth century. And yet this fairly amazing advance in bank note engraving is exhibited — as the special art itself was invented — in the United States alone. The Bank of England, after printing for more than a century notes so simple and inartistic that they might be counterfeited by any lithographer or wood-engraver, and also by any expert penman, owes the very few improvements adopted to American invention, and even now prints its notes from electrotypes. The notes of the Bank of France, and other continental issues, are a little, but not much, better; while all the European bank notes, by their simplicity of design and comparative coarseness of execution, fairly invite counterfeiting.

The Art in America.

To Jacob Perkins, already mentioned as the inventor of engraving on steel, we owe much of our superiority over all other nations in this particular art. His discovery of the transferring process made it possible to produce, at a reasonable cost, steel bank note plates and parts of plates, with vignettes and decorations capable of almost infinite combinations, thus giving the banks throughout the country issues which appealed to the eye and the taste by their beauty, and necessitated that the counterfeiters should at least be first-class engravers. Not but that counterfeiting has been frequent, for what one engraver can do can be done by another; but the constant progress in the art, and the introduction of intricate and expensive machinery for some portions of the work, have lessened the number and the danger of counterfeits year by year, while the art itself has now reached a point of perfection beyond which further progress seems almost impossible.

The invention of the transfer process, the introduction of lathe work, the employment of superior designers and engravers, and the immense demand for plates in every section by banks, all competing with each other in issuing the "handsomest bills," very soon made bank note engraving a most important industry in this country. The five or six great companies, which had the capital to buy or build the best machinery, secured the best talent, and were able to keep on hand large stocks of plates, vignettes, and designs, and have branch offices in nearly every state where bank notes were demanded. In 1858 nearly all the leading firms united in what is known as the American Bank Note Company, thus combining capital, stocks, experience, the best engravers in the separate companies, and securing almost a monopoly of the business, as well as of the similar elaborate engraving of plates for checks, drafts, certificates of stock, bonds, etc., with much other of the finer sort of engraving required especially by business men, corporations, and mining and manufacturing companies. This combination, which then nearly controlled the entire bank note engraving of the United States, and thus brought the whole, as it were, under one supervision, materially lessened the opportunities for counterfeiting, or altering the denominations of notes, since it could afford to banks more elaborately engraved plates at nearly the same rate heretofore paid for inferior designs.

The Processes of Bank Note Engraving.

The present processes of bank note engraving, which is, in some of its details at least, the highest style of engraving in America, are, in brief, as follows: All the "pictures," such as portraits, views, copies of celebrated paintings, or vignettes of whatever character, are engraved by first-class artists in *line* engraving upon small pieces of plate, which are softened and annealed. When the engraving is finished, and the proof is satisfactory, the plate is hardened, and is then transferred to another plate, or more frequently to a steel cylinder, which, when hardened in turn, presents a raised impression, which will cut, in the short space of fifteen minutes, by pressure or by rolling under heavy pressure, a duplicate of the original plate on the plate finally to be used in printing. This is an important part, but by no means the whole of the work. Other portions of the plate for the note have been cut by machinery, and transferred to the plate; the "counters," on which the figures of the denomination of the note are printed, have been put in by lathe-work patterns; and indeed the greater part of the plate, even the lettering, formerly all done by hand on the plate itself, is now done by machinery, leaving, if anything, only the large figures indicating the denomination to be cut in by the engraver. The plate, thus completed by the various transfers, is now hardened, and is ready for printing. It will thus be seen that where the engraving of a vignette may occupy weeks, with the transfer of this, and transfers of other portions of the work originally done by the engraver or by machinery, the actual preparation of the plate for printing is made the work of a few hours only. The plates for printing, as made by the transfers, are thin plates of steel, with sometimes two, three, or four notes on a plate, and sometimes a single note. Notes of the larger denominations, one hundred dollars and upwards, requiring fewer impressions than the lesser notes, have sometimes been engraved on copper.

In printing from the plates, the same care is necessary as in the best plate printing, and special presses are used which will register every impression taken, so that not a single sheet can be abstracted by dishonest persons during the process. After printing, the sheets are dried, and are subsequently pressed under hydraulic pressure. The numbering of the notes with red, or other colored figures, is done by a curious machine, which itself seems to count intelligently.

United States Treasury and National Bank Notes.

The recent system of United States Treasury and National Bank Notes, which has given a similar currency to the entire country, has done away with the vast variety of designs which were displayed in the state bank bills. Thus, whatever the face of a national bank note may display, as to state, city, name of bank, etc., etc., the backs of all these bills, according to denomination, display the same design, which, for different denominations, is a copy of one of the historical pictures in the rotunda of the Capitol at Washington. In 1862, when the government made its first issues of what are popularly called "greenbacks," the work of designing and engraving the face of these issues was intrusted to the American Bank Note Company, another large company securing the first contract for the work on the backs. All the resources of the American Bank Note Company were brought to bear in the production of these elaborate and most artistic plates. The most eminent engravers in the country were employed to engrave the portraits and other vignettes, and all that taste, talent, and machinery could do, was employed on these issues. Every guard in device and in tint that could be devised to prevent copying, by photography or counterfeiting by engravers, was introduced. The result has been that in the greenbacks, and in the subsequently issued National Bank notes, have been exhibited the most perfect specimens of bank note engraving ever executed in America, and consequently ever shown in the world.

CLOTHING.

CLOTHING IN OLD TIMES. — HOMESPUN AND HOMEMADE. — THE FIRST INNOVATION ON THE PRIMITIVE STYLE. — THE CUTTER. — THE VILLAGE TAILOR. — SLOP-SHOPS FOR SAILORS. — HOW JACK WAS CHEATED. — SECOND-HAND CLOTHING BUSINESS. — CLASS OF CUSTOMERS. — WHAT BECOMES OF OLD CLOTHES. — CHEAP READY-MADE CLOTHING. — THE CLOTHIERS OF TO-DAY. — SUPERIORITY OF THEIR GOODS. — ADVANTAGES OF THE BUSINESS. — THE BEST CLOTHING FOR THE BEST PURCHASERS. — REVOLUTION IN FASHIONS. — BEGINNING OF THE CLOTHING BUSINESS IN NEW YORK. — REVULSION OF 1837. — REVIVAL OF THE TRADE. — ITS PRESENT MAGNITUDE. — FELT SEAMLESS CLOTHING. — IMPULSE TO THE TRADE DURING THE CIVIL WAR. — SHODDY UNIFORMS. — REQUIREMENTS FOR A FIRST-CLASS ESTABLISHMENT. — HOW THE BUSINESS IS CONDUCTED. — EMINENT CLOTHIERS. — JOHN SIMMONS. — ANDREW CARNEY. — MACULLAR, WILLIAMS, AND PARKER, OF BOSTON. — AN EXTENSIVE MODEL ESTABLISHMENT. — THEIR BUSINESS. — DESCRIPTION OF THE DIFFERENT DEPARTMENTS.

UNTIL within comparatively a few years, men's and boys' clothing, like women's clothing, was almost entirely an article of home manufacture; that is, the clothes were actually cut and made in the household where they were to be worn. This was especially true in the rural regions of the United States, when every farmer's wife knew how to weave wool into stout "homespun" cloth, and could dye it, cut the clothes, and make serviceable, if not elegant, articles of apparel. This is still true of many parts of the country, particularly of newly-settled portions of the West and South, where the well-known "butternut" cloth of home manufacture supplies good stout clothing for farmers and their sons. In the old colonial days, country housewives vied with each other in weaving cloth, and during the Revolution, when embargoes and prejudice alike prevented the importation of foreign cloths, the best and richest men in the country appeared in the legislature, in Congress, and everywhere in public, in well-made suits of handsome cloth, which they boasted was of strictly "domestic manufacture," the wool being grown, the cloth manufactured, and the clothes cut and made, "at home."

The first innovation on the primitive and independent manufacture of clothing in and for the household was the employment of some expert, — generally a woman, — who went from house to house, and cut out the clothes, which the wife and daughters of the household subsequently made up. Then came the village tailor, who took the homemade cloth, and cut and made the clothes. The growth of villages and towns might be marked by the number and the business of the tailors. The next step in advance was joining the business of the draper, or one who sells cloth, to that of the tailor, so that those who did not make their own cloth, or buy from the manufacturers to take to the tailor, could select what they wanted in the shop where they were measured for new suits. The number of misfitting garments, which were turned back on the tailor, and which had to be sold to some one whom they did fit, or more nearly fit, may have suggested the idea of making suits of different sizes to be sold ready made to those who might desire them. The enormous and perfect business in this line, which is now conducted in every leading city in the United States, and in nearly every important city in the world, was an aftergrowth.

The business may be said to have begun with the cheap "slop-shops," as they are called, which fitted out sailors with all the clothing they wanted for long or short voyages, and with thick and thin articles of wear for different climates. With this branch of business was generally joined a supply of hats, shoes, canvas bags, thread, combs, soap, needles, knives, scissors, and such small stores as were necessary to make up the sailor's "kit." It is presumed with the growth of this business, and particularly with the competition which has sprung up in the trade, that "poor Jack" is better and more cheaply served than he was in the days when the slop-sellers in cities and in seaport towns were either sailor boarding-house keepers, or in league with these and other sharks, who fattened upon Jack, and who sold him ill-made and ill-fitting clothing of the worst materials at exorbitant prices. The time has gone by when *all* the sailors' out-fitting shops were of this character; there are enough of precisely this kind now; but in most seaport places there are perfectly respectable and fair-dealing stores and shops, which supply excellent clothing for sailors at most reasonable prices, so that Jack as his own tailor on shipboard is a much rarer spectacle than he was a few years ago.

The second-hand clothing business, largely conducted by Jews,

who bought, cleansed, and repaired old clothing, making it "as good as new," and sometimes selling it as if it was new, became in a few years so important a traffic that almost every town of any consequence in the country had its miniature representative of Chatham Street in New York. A very large business is done in New York, Boston, and Philadelphia in restoring, and sometimes remaking, the old clothes which are picked up by agents or smaller second-hand clothing dealers, and which are sent to the South and West, and frequently abroad, to be sold at retail. The clothing is bought sometimes for money, but more frequently for fancy china and porcelain, or other goods, which pedlers carry about the country to exchange for old clothes, thereby making a considerable profit on both what they sell and what they buy. If trustworthy statistics of this business could be gathered, the trade would be shown to be an enormous one, giving employment, the means of livelihood, and in some instances much wealth, to a large class of people. The number of advertisements in the city papers for second-hand clothing, for which "the highest prices" will be paid, is an indication that the business is extensive and profitable. Old clothes, by skilful cleansing and repairing, and, if necessary, dyeing, become new clothes for a second set of wearers.

The next step which the slop and second-hand clothing business suggested was cheap ready-made clothing, manufactured from low-priced and slightly damaged goods. Cloths partially damaged by fire or water were worked up into clothing, which found a ready sale in cities. All ready-made clothing, in the earlier stages of the trade, was called "slop-work," and the most of it deserved no better title. Poor and cheap coarse cloths were generally worked up; no special attention was paid to fit or fashion; most of the work was done at starvation prices by women, and the goods were bought and worn by those who could not afford to employ a tailor or buy better articles. It is doubtful if there was any economy in such purchases, for the shiny cloth soon took on a dingy, rusty hue; the "all-wool" cloth turned out to be more than half cotton; and the garments were so hastily and poorly put together that they soon came to pieces. There was a time when a ready-made garment of any kind could be readily recognized almost as far as the wearer could be seen. Hence there was a sort of shame in the purchase and wear of such clothing, and it was considered almost disreputable to buy it; it was at once a reflection upon a man's taste and a supposed indication of his poverty.

Very different is it nowadays, when the most fashionable young men avail themselves of the extensive, well-made, and admirably-fitting stocks of retail clothiers, to fit themselves out with suits made of the best of cloths for business wear, and even for full-dress occasions. There are thousands of men, even among those who are most fastidious in matters of dress, who never think of being measured for a suit of clothes, but who go to a clothier, and supply themselves from his stock. The obvious advantages are the saving of time and the better chance of getting exactly what one wants; but in addition to these there is a further opportunity of getting a better and better-fitting article at a much more reasonable price than that for which one could order the same goods from a tailor.

From the cheap ready-made clothing to better clothing for a better class of customers, the advance was natural, and a new, respectable, and remunerative business was inaugurated. Overcoats were among the ready-made goods of the more expensive class which first became popular. These, at the very outset of the business, were made every summer for the fall and winter trade, and men who still depended upon their tailors for everything else found it very convenient to go to a clothier for a handsome, well-made overcoat, which could be selected from a great variety, and of quality and price to suit every purchaser. Then the country was flooded with linen dusters and summer suits, the best of which could be bought cheaper than a tailor would make them. Spring and fall light overcoats, which in times gone by scarcely one man in a thousand thought of ordering made for him, are now almost universal, simply because the clothiers brought them into market, and made them as fashionable and indispensable as they are cheap and convenient. Indeed, to the makers of ready-made clothing we owe a complete revolution in our fashions. To them is due the banishment of the once universally-worn black clothes, including such abominations as black satin vests, — the funereal garb appearing at all times and in all seasons, — and the substitution of the great variety of neat business suits of tasteful colors and handsome shape. Cloth manufacturers now make a vast number of beautiful patterns, expressly to meet the demands of the clothiers; and so far as the style of clothing goes, what we call "the fashion," from year to year and from season to season, is now furnished by the clothiers to the tailors, and not by the tailors to the clothiers. It is generally the case, too, that a first-

class city clothier is able to furnish everything essential to a gentleman's wardrobe; and so complete are some of these establishments that they might boast of their ability to clothe, at a moment's notice, the "naked truth."

The wholesale clothing business began in New York about thirty-five years ago, and almost immediately assumed an importance. It gave employment to thousands of women and girls, who were very glad to work even for the poor wages they then received for their labor, and men in considerable numbers were employed in cutting and in making the heavier garments. The financial crisis of 1837 was most disastrous to this business, and the sudden throwing out of employment of a large number of workmen and sewing women created much suffering. In a short time, however, the business revived again, and from that time forward it steadily increased, spread to other cities throughout the Union, and has now become one of the most important industries in the United States. Within twenty-five years, in 1860, there were nearly four thousand clothing manufactories, — exclusive of those devoted to making shirts, collars, and articles of men's underwear, — which required twenty-five millions of capital, employed one hundred thousand persons, and made nearly eighty million dollars' worth of goods, of which five eighths were made in the Middle States.

In New York, Massachusetts, Pennsylvania, and in one or two more states, patents have been taken out, and manufactories established, for the production of felt seamless clothing, which has become quite an important business.

The civil war (1861–5) gave an immense impulse to the clothiers' business in the demand for thousands upon thousands of uniforms, and enormous fortunes were made by many of the contractors. Some of these contractors attained an unenviable notoriety by furnishing the soldiers with shoddy uniforms, which were little better than brown-paper suits for service in the camp and field. The introduction of sewing machines, and other labor-saving devices, wonderfully facilitated the ready-made clothing manufacture, and since 1860 the business has so increased that it is estimated as the third in importance in the industries of the country.

An extensive wholesale clothing establishment must be conducted with the greatest skill and economy in the management of every department. The cloths are bought months before the season when they are to be worn, in order to give time to make them up. The cloths are to be cut, the buttons, thread, linings, etc.,

are to be supplied, and a careful account in every department must be kept before the work is given out. The large houses employ superior cutters, and the workmen and workwomen generally use sewing machines, which their wages enable them to hire, or to pay for in small weekly or monthly instalments. As the cloth is bought long before it returns to the clothier in garments, and as his goods are sold sometimes on credits of several months, the business requires a large capital, and a large amount of money is needed for the weekly payment of the hands. In New York thousands of Germans and others work for the clothiers ; in New England the garments are cut in the cities, and are then sent to, or taken by, workwomen in the country, who make the clothes and return them. Thus, in addition to the vast amount of work furnished to those immediately employed in and near the city establishments, the clothiers supply the means of livelihood to thousands of farmers' and laborers' wives and daughters in the interior towns remote from Boston and other centres, but with which communication is frequent and easy by railroad. In addition to the manufacture of men's clothing, the making of boys' clothing in infinite variety is an important department in all large clothing establishments, and a few of them are exclusively devoted to this branch of the business. Nearly all of the large establishments in the principal cities have, besides their wholesale department, a retail department, a custom department, — making goods to measure for customers, — and sometimes a general furnishing department.

Among those who have made large fortunes in the clothing trade are the Devlins, and Brooks Brothers, in New York ; the late John Simmons, of Boston, who bequeathed two million dollars to endow a female seminary ; and the late Andrew Carney, by whose liberality the Carney Hospital at South Boston was established. Several other extensive wholesale dealers in New York, Boston, and Philadelphia have attained high rank in the mercantile and manufacturing world, and have made themselves very wealthy, besides giving remunerative employment to thousands of persons.

Twenty years ago the manufacture of ready-made clothing in Boston was located principally in Ann Street, and in the immediate vicinity. Prominent among the clothiers in 1852 was the firm of Messrs. Macullar, Williams, & Parker, whose steady increase of business and the imperative demand for more commodious premises necessitated their removal, in 1854, to Milk Street. At

WAREROOMS OF MACULLAR, WILLIAMS & PARKER, BOSTON

first their business was exclusively confined to the wholesale trade; but a constant application for their goods at retail induced them, in 1857, to remove to Washington Street, to what was formerly the old "Washington Coffee-house," one of the revolutionary relics of the city. In 1860 the increase in their business compelled them to remove to the large store previously rented to the well-known firm of George W. Warren & Co., and here they added a custom department.

Another removal was soon imperative, and they had a store built for their business. By a contract with the trustees of the estate of Joshua Sears, the beautiful marble building, No. 200 Washington Street, now occupied by the firm, was built expressly for their use. Their business comprises the following departments: An importing and wholesale cloth department, a wholesale clothing department, a retail clothing department, a custom clothing department, and a furnishing goods department.

The building, which is one of the finest in the city, has a frontage of fifty feet on Washington Street, and runs through two hundred and fifty feet to Hawley Street. The basement, which has about twelve thousand square feet of flooring, is devoted to the reception, examination, and sale of cloths and other materials bought from commission merchants, or directly from foreign and domestic manufacturers. The firm import fine woollen goods of English, Scotch, French, and German manufacture, for their own use and for supplying tailoring establishments throughout the country.

The first story affords an immense sales-room for ready-made clothing at retail. It is two hundred and fifty feet long, by fifty feet in width, and twenty feet high, finished in oak, and contains the counting-rooms and public and private business offices of the establishment. The second story is devoted to the sale of manufactured clothing at wholesale. In the third, fourth, and fifth stories are cutting and manufacturing rooms, containing twenty-five thousand feet of flooring, and here are employed men, women, and children engaged in various departments of the manufacture. There is also a separate department for the manufacture of white linen summer garments, among which may be mentioned the making of no less than fifteen thousand white vests in a year. The same hands are employed in this department the entire year through, which has given this style of goods, manufactured by Messrs. Macullar, Williams, & Parker, a reputation for

uniform excellence that has led to a constant demand from all parts of the country.

Messrs. Macullar, Williams, & Parker employ five hundred hands in their building, and all their custom and ready-made clothing, both for the wholesale and retail department, is made under the immediate supervision of the firm, whose main object has been from the beginning of their business to establish a reputation for thoroughly trustworthy work. The attainment of this purpose has given this firm a character and business standing second to no other house in the whole country.

ARMORED VESSELS AND ARTILLERY.

IRON-CLAD VESSELS. — ROBERT L. STEVENS. — THE STEVENS BATTERY. — JOHN ERICSSÖN. — HIS INVENTIONS. — CONGRESSIONAL APPROPRIATION FOR IRON-CLADS. — THE FIRST MONITOR. — THE REVOLVING TURRET. — NEW AND LARGER MONITORS. — PURITAN, DICTATOR, MONADNOCK, MIANTONOMOH, AND KALAMAZOO. — SEA SERVICE AND HARBOR DEFENCE. — ANCIENT ARTILLERY. — CHINESE THE SUPPOSED INVENTORS. — ARTILLERY IN THE FIFTEENTH, SIXTEENTH, AND SEVENTEENTH CENTURIES. — FREDERICK THE GREAT. — GERMAN ARTILLERISTS. — NAPOLEON. — ARTILLERY IN AMERICA. — CANNON IN THE COLONIES. — FIELD GUNS IN THE REVOLUTION. — MODERN ARTILLERY. — DESCRIPTION OF THE DAHLGREN, RODMAN, PARROTT, WIARD, AND AMES GUNS. THE GREAT CANNON FOUNDERIES OF THE COUNTRY. — WEIGHT AND RANGE OF GUNS. — PROJECTILES AND TORPEDOES. — USES IN THE LATE WAR. — AMERICAN INGENUITY AND INVENTION.

To Robert Livingston Stevens, who was born at Hoboken, New Jersey, in 1788, and died there in 1856, belongs the invention of applying iron plates to vessels as a defence against shot and shells. He made the discovery in 1811, and in 1842 he began experiments for a floating shot and shell-proof battery, making a contract with the Navy Department for its construction in 1849. The plan proposed a large vessel to be built entirely of iron, and the work was not begun till 1856. It has since been carried on at intervals by the executors of the estate, and, in 1871, after costing many hundreds of thousands of dollars, is not yet completed. Operations have been carried on with an assumed secrecy, though full descriptions of the battery, so far as it has progressed, have been published in the New York journals. The Stevens estate appropriates money for its completion, and when finished the battery becomes, under certain conditions, the property of the State of New Jersey. It is presumed to be the largest and most powerful vessel of its kind yet projected.

John Ericsson, now of New York, is the inventor of the iron

turret as applied to armor-clad vessels. He was born in Sweden in 1803, and entered the army as an ensign in 1820, soon attaining a lieutenancy. In 1826 he went to England to introduce his flame engine. In 1833 he perfected his caloric engine. In 1839 he came to the United States, and two years later he was engaged in the construction of the United States ship of war Princeton, the first steamship built with machinery placed under the water line out of reach of shot. The same vessel also exhibited other ingenious improvements suggested by Mr. Ericsson. A mere enumeration of his many important inventions would fill a large catalogue. A new form of the caloric engine was introduced in the ship Ericsson in 1852, and the Secretary of the Navy recommended an appropriation of five hundred thousand dollars to build a similar ship for the government. The recommendation failed in Congress, but the engine has been successfully employed in numerous manufacturing establishments.

In 1854 Mr. Ericsson made his first model for an iron tower on an armor-clad vessel. Experiments had heretofore been made in iron plates as a defence for ships, Robert L. Stevens and E. A. Stevens having suggested them for coast and harbor defence as early as 1816 ; and with this view, plates were tested in England in 1840, in the United States in 1852, and in France in 1854. In 1860 the French iron-clad La Gloire, and in 1861 the English Warrior were built, neither of them having the sea-going or offensive as well as defensive powers subsequently developed in the American iron-clads.

Soon after the commencement of the civil war, in 1861, Congress appropriated one million five hundred thousand dollars for the construction of one or more armored ships. Plans were presented by seventeen different inventors, manufacturers, or companies, and of these three were accepted — the corvette Galena, plated with iron three inches thick, and hulled through and through by ten-inch shot in the attack on Fort Darling ; the frigate New Ironsides, which, with her battery of eleven-inch guns, proved very effective in attack ; and Ericsson's Monitor, which introduced the principle upon which all the successive and successful iron-clad batteries were built.

The principle of the Monitor, and of all vessels on the same general plan, with such modifications as may be adopted, is the revolving iron turrets, which shields the battery, and the power to submerge the hull so that the deck is but a few inches above

water. The model was generally ridiculed, and was popularly known as a "cheese-box on a raft;" but when the Monitor encountered and defeated the Confederate iron-clad Merrimac at Hampton Roads, public opinion changed, — indeed, was enthusiastic, — and forthwith government ordered the construction of ten monitors, of eight hundred and forty-four tons each, with one turret and two eleven and fifteen-inch guns.

The advantage in the Monitor, on which the invention of Ericsson rests, is the revolving turret, in which the guns and their shot-proof shields turn together, so that whatever may be the position of the ship, or even if the ship is aground, the guns can instantly be trained round the entire circle to any point of the horizon. Mounting the battery in the centre, and directly over the keel, permits the use at sea of the heaviest American guns, with no danger of rolling the vessel under, or tearing her to pieces. In addition to the steadiness of this class of vessels at sea, the power of submerging allows the heavy armor to be placed only on the small surface exposed, when a similar thickness on the whole broadside would sink the vessel. The monitors of all classes require also a comparatively small number of men to work them.

The original Monitor had an extreme length of one hundred and seventy-three feet; beam, forty-one feet six inches; depth, twelve feet; thickness of armor above the water line, five inches, diminishing below to four and three inches; thickness of wood above water, two feet three inches; the turret, twenty feet in diameter and nine feet high, was constructed of eight thicknesses of one-inch iron plates; armament, two eleven-inch guns.

The nine monitors next built were two hundred feet long on deck, and, while built on the general plan of the first, were superior in speed and in construction. The turrets were eleven inches thick, and some of them carried one eleven and one fifteen-inch gun, and others a fifteen-inch smooth-bore and a Parrott rifle, a 150-pounder or a 200-pounder. Eight vessels of this class, with the Ironsides carrying thirty-two guns, were engaged in the attack on Charleston, when the turret of the Passaic was disabled, and the Keokuk alone was sunk.

The next class of monitors built by the government were two hundred and twenty-five feet long, and of one thousand tons burden, with side armor, besides the wooden backing, equal to eleven inches thickness of iron. The government next constructed the Puritan and the Dictator, one of them double-turreted, both on the

Monitor plan, and intended as swift ocean cruisers. The ram frigate Dunderberg, built by W. H. Webb, of New York, and subsequently sold to the Russian government, was a combination of the advantages of the turreted and broadside vessels. She is three hundred and seventy-eight feet long, sixty-eight feet wide, and thirty-two feet deep, and so far as armor and armament go, a more formidable ship was never built.

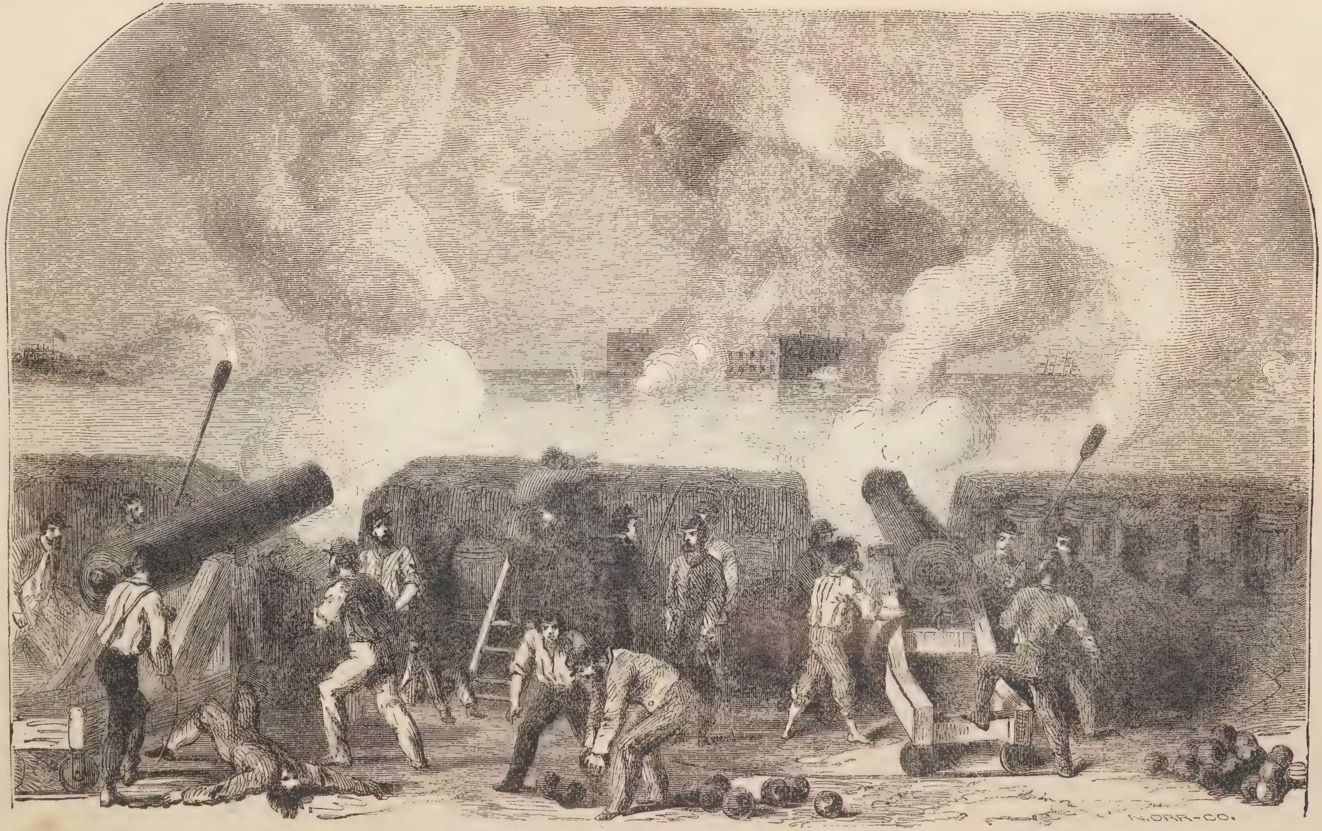
The Monadnock and Miantonomoh, double-turreted ocean cruisers, with a speed of eleven knots, represent the next class of monitors planned by the government. They are two hundred and fifty-seven feet long, with turrets twelve inches thick, side armor eleven inches thick, and armament four fifteen-inch guns, capable of throwing a broadside of eighteen hundred pounds of solid shot. A still more formidable class, represented by the Kalamazoo, has a length of three hundred and forty-two feet; breadth, fifty-six feet eight inches; depth, twenty-one feet six inches; iron plating, fourteen inches thick; thickness of deck, twelve inches, including three inches of iron plating; and turrets, fifteen inches thick.

Nearly all these vessels were built by contractors, and were armored with American rolled plates. Their success in the late war shows their perfect adaptability to the required conditions, that they should be shot-proof, able to fight in shallow water, and equally able to endure a heavy sea. In all the engagements with forts on shore, the loss of life on board the monitors was singularly small. In competition with the Confederate iron-clads, the monitors were generally the conquerors, and their use shows them to be invaluable both for service at sea and for harbor defence.

Ancient Artillery.

Setting aside the claims of the Chinese, who assume to have had artillery as early as 618 B. C., it is conceded that the invention of guns and gunpowder is of Eastern origin, and the Moors in Spain, who used artillery at the siege of Saragossa, in 1118, introduced the new weapons of warfare into Europe one hundred and fifty years before the alleged discovery of Roger Bacon. The Spaniards took Gibraltar with cannon in 1308. Some historians state, and others deny, that the English had artillery at the battle of Crecy in 1346. The Venetians used cannon against the Genoese in 1378. The guns of the fourteenth century, however, were of extremely rude construction, and from their facility in bursting were nearly as dangerous to friends as to foes.

AMERICAN SHIPS OF WAR AND GUNBOATS.



BOMBARDMENT OF FORT SUMTER APRIL 12 1861.

In the fifteenth century great improvements in artillery were made, and guns, heretofore made by hooping iron bars together, were cast in iron, copper, and brass. Charles VII., of France, introduced guns with trunnions, carriages on wheels, and iron shot instead of stones or other projectiles. His successors added other improvements, tending to lighten field artillery. With the seventeenth century came the introduction of cartridges, grape shot, case shot, hollow shot, mortars, howitzers, shells, fuses, and, withal, a complete revolution in the art of fortification, which the new implements of war demanded. In the wars of Louis XIV., complete artillery trains of as many as two hundred guns were frequent. In 1690 France founded the first artillery school. In the beginning of the eighteenth century most European countries incorporated the artillery service regularly in their armies. Frederic the Great introduced the effective service of horse artillery, and before the close of the eighteenth century Germany developed the leading scientific artillerists of the age. Napoleon was a born artillerist, and with light field guns and immense numbers of them he conquered all Europe.

After the downfall of Napoleon, in 1815, the artillery of Europe was greatly improved by the abolition of light calibres, and the introduction of heavier artillery of the English model. Among recent European rulers, Louis Napoleon paid great attention to improvements in artillery, and the late continental wars have led to the invention and introduction of new arms for sea, field, and fort service ; heavy guns for ships and fortresses, pivot guns, shell guns, mitrailleuses, etc.

Artillery in America.

According to one of the historians of New Netherlands, the Massachusetts colonists, as early as 1664, were casting cannon and cannon balls. In 1748 a foundery at Bridgewater, Massachusetts, made guns of from three to forty-two pounders in brass and iron, cast solid, and then bored. During the Revolution cannon, cannon balls, and shell were made in Massachusetts, Rhode Island, Connecticut, New Jersey, Pennsylvania, and Maryland, and were distributed in considerable quantities throughout the country. William Denning, of Cumberland County, Pennsylvania, made a very effective wrought iron gun of iron staves, hooped, and boxed, and breeched like other cannon. At Springfield, Massachusetts, and at Salisbury, Connecticut, guns of from four to thirty-two

pounders were made. Reading and Warwick, in Pennsylvania, were important seats of this manufacture. A contract was made with the Hughes Brothers, of Frederick County, Maryland, for one thousand tons of cannon, upon which the sum of eight thousand dollars was advanced, and subsequently an additional twenty-two and two thirds dollars per ton was paid. Indeed, through the Revolution abundant artillery of American manufacture was furnished, and additional supplies were secured by capture. A well-known revolutionary anecdote makes a British officer ask, with surprise, "Where do you Americans get all your guns?" "We make them." "But where do you get your patterns?" "At Saratoga," was the reply.

In 1810 there were several founderies in the country, which cast shell, shot, and cannon of small calibre, and at Cecil County, Maryland, near Washington, and at Richmond, Virginia, three establishments were started, capable of casting the largest guns, and with machinery for boring them, each of them able to turn out pieces at the rate of three hundred a year. In 1813 a brass foundery at Watervliet, New York, made cannon by contract for Connecticut. The following year Joseph McClurg's iron foundery was established at Pittsburg, Pennsylvania, which cast the cannon for the fleet on Lake Erie, and for the defence of New Orleans. Previous to 1836 patents were granted for an improved method of elevating cannon, and for a many-chambered cannon. Up to 1857 about three hundred patents for cannon, projectiles, and other implements of war were recorded in this country.

Among the heavy guns of American invention, the most important are the Dahlgren, the Rodman, the Parrott, the Wiard, and the Ames, named respectively after the inventors. Lieutenant, subsequently Rear-Admiral John A. Dahlgren, became connected with the Ordnance Department at Washington in 1847, and during his long connection with the service, he effected many important changes, and introduced several inventions, such as light boat howitzers, with iron carriages, for field service, and his heavy shell gun. The Dahlgren guns, generally of smooth bore, are distinguished by their peculiar shape and the heaviness of the breech, which materially lessens, if it does not prevent, the tendency to recoil. The guns are cast, and after cooling are annealed, and are turned down to the required size. The Dahlgren ten-inch shell gun has a length of bore of one hundred and seven inches; the eight-inch shell gun, with a length of bore of one hundred inches,

weighs sixty-three hundred weight, and at five degrees elevation, at nine feet elevation above water level, with a charge of nine pounds of powder, has a range of seventeen hundred and seventy-six yards.

The Rodman gun, on the principle of which all the heavy ordnance of the United States is now made, is cast on a hollow core, in which water is introduced, so that the metal is cooled from the interior, which gives greater hardness to the interior surface, and renders guns less liable to burst.

The Parrott rifled guns and projectiles proved very serviceable in the late war. The first Parrott gun was cast at the West Point Foundery in 1861. The year following the inventor began to make two-hundred-pounders of eight-inch calibre, and afterwards three-hundred-pounders of ten-inch calibre.

Mr. Norman Wiard, of the Trenton Wiard Ordnance Works, made the first steel guns in this country, and his field batteries, with improved carriages, attained high reputation for their range and precision. He also made heavy steel rifled guns for naval service, and fitted out the Burnside expedition to North Carolina with its entire armament. In 1864 he constructed a large navy gun at a cost of eighty thousand dollars — the largest in the country, with the exception, perhaps, of the Rodman, at Fortress Monroe.

Mr. Horatio Ames, of Falls Village, Connecticut, invented, in 1854, a wrought-iron gun, which is stated to surpass other guns, of equal weight, in its power to sustain heavy charges with no danger of explosion.

The great cannon founderies of the United States are at West Point, the Fort Pitt Works, at Pittsburg, and the Scott Foundery, at Reading, Pennsylvania. The Fort Pitt Works have been in operation since 1813. It was in this establishment that lieutenant, subsequently General Rodman, while superintending some work for government, conceived the idea of casting guns hollow, and cooling them from the interior. In 1859 the fifteen-inch Rodman gun, weighing forty-nine thousand pounds, and capable of sustaining charges of from thirty-five to fifty pounds of powder, with shells weighing from three hundred to three hundred and thirty pounds, was successfully cast at these works, and was removed to Fortress Monroe, where it was repeatedly fired. Following this have been guns with enlarged calibres — two of twenty inches, capable of throwing a projectile weighing a thousand

pounds. The Scott Foundery, at Reading, has manufactured many guns of fifteen-inch calibre, weighing forty tons.

Projectiles and Torpedoes.

It has been noted in the foregoing that shell, as well as cannon shot, were manufactured in this country during the Revolution. In 1813 Robert Livingston Stevens, the inventor of iron-plate armor for ships, invented an elongated bombshell, and imparted the secret of its construction to the government, receiving in return a considerable annuity. During the late civil war many patents were granted for new and most destructive projectiles, some of them of many hundred pounds weight, which could be thrown by the large guns to a distance of four and even five miles.

Torpedoes, designed for blowing up ships, were used against the British fleet during the Revolution. Robert Fulton, the inventor of the steamboat, devised a very ingenious and effective torpedo in 1805. The modern use of the electric battery in firing them has made torpedoes doubly dangerous. During the late war in the United States torpedoes were freely used in the Southern waters, and sometimes with most destructive effect. American ingenuity has brought the construction of these terrible implements of warfare to great perfection.

LINEN COLLAR AND CUFF MANUFACTURE.

ANCIENT PROHIBITION OF SEWING. — SUBDIVISION OF LABOR. — SIGNIFICANCE OF WHITE UNDER-CLOTHES. — STATISTICS OF COLLARS AND CUFFS. — HOME-MADE COLLARS. — SCALE OF MESSRS. CLUETT BROS. AND CO.'S WORKS. — PROCESS OF GETTING OUT A NEW STYLE. — SIZES OF PEOPLE'S NECKS. — CUTTING THE CLOTH. — SERIES OF OPERATIONS IN SEWING. — THE SEWING-MACHINE ROOM. — THE LAUNDRY AND ITS INVENTIONS. — FINISHING AND INSPECTION OF THE GOODS. — FORETHOUGHT AND ENTERPRISE IN PREPARING BUSINESS. — THE PARASITIC METHOD OF DOING BUSINESS. — RELATIONS WITH OPERATIVES. — REQUISITES OF MEN'S AND WOMEN'S GOODS.

It is a curious fact that processes of manufacture have been prohibited, not only from business prejudice, but from religious feelings, as mistaken as those of the pious old gentleman who actually argued against canals, within a century, because, he said, if God had meant to have water run in these channels, he would have made it do so. Until the period of the Mohammedan invasion of India (A. D. 664), it was universally held a sacrilege in that country to wear garments made from pieces of cloth sewed together. Every garment was therefore woven in a single piece, or cut from a larger one; needlework was at an enormous discount; and the sewing machine would have been reckoned a tremendous engine of wholesale damnation.

It is far different now. The tendency to multiply the varieties of all manner of commodities, to apply machinery to the making of separate parts of each, on wholesale principles, and to divide and subdivide those parts almost to infinity, has become the very spirit of the age; and the employment of the sewing machine is one of the very latest, and largest, and most wonderfully useful of all the steps of this social progress.

The first period in the history of dress was that of skins and fig leaves. Next came the use of woven fabrics, but thus far

always of family make. Then those better gifted or situated for the purpose began to weave goods for others to make; and "purple and fine linen" are among the very earliest commodities named in the history of commerce.

The ready-made clothing business, of comparatively recent date in Christendom, was obviously likely to be introduced far earlier where garments were mostly constructed on the model of a sheet. There have, however, been "slop-shops" in Europe for centuries, although the application of the wholesale methods of modern manufacture has been much later; and after the separate clothing business had grown up, and even after a still further division had set apart the under-clothing business, and yet again the men's under-clothing business, came the latest subdivision of all — the collar and cuff business. It remains to be seen whether extensive business houses will be founded in the future for nothing except to make button holes. The button business is already set apart.

Cleanliness and white garments always go together; and the frequent mention of the two in the Bible is, as it most evidently must naturally be, in precise harmony with the constitution of humanity. Where any clothes at all are worn, it will be found that white under-clothes go with cleanliness of the person.

Dress serves more than one purpose. It is for modesty, for comfort, and for ornament. And the tendency of modern improvements in costume is, to serve all three of these purposes, and at the same time to avoid interference with the requirements of business engagements and physical activity. Now, the most characteristic and elegant finish of modern costume is given by permitting the appearance of the white margin of the innermost garments at the neck and wrists, those being the only places (except so far as ladies allow their shoulders, arms, etc., to be visible) where the person is uncovered. The white borders thus displayed are themselves an agreeable finish, in point of color, for artistic reasons; they also give the further agreeable intimation of physical cleanliness; and they are susceptible of being treated with a great variety of effective and graceful ornament.

It is evident that the daily emergencies of life should soil more rapidly white surfaces exposed to the outer atmosphere than those which are covered; and this is a sufficient reason for putting on a clean collar and clean cuffs oftener than a clean shirt. There are no authentic statistics of shirts, so far as our present knowledge extends, but it requires no very complicated calculation to

show that the number of collars and cuffs which must be manufactured in the United States in a year is immense. We have a population of about forty million persons. Suppose the very liberal allowance of one quarter deducted as too young for such elaborate articles of costume, and another quarter as too slovenly or too poor, and twenty millions remain. Now, at six collars and six pairs of cuffs each, — an extremely moderate rate, — being eighteen items in all, the United States at any given moment is using three hundred and sixty million articles of white goods — or thirty million dozen — for dress finish at neck and wrists. These six collars and six pairs of cuffs will not, on an average, last more than a year; and therefore the above total quantity must be manufactured anew every year. Even if these sums total should be greatly too large, it remains beyond question that the actual totals are enormous.

The history of arts and trades shows many instances of the concentration, for one reason or another, of the manufacture of some one article in some one place. Thus the hat business has been established at Danbury, Connecticut, for more than a hundred years; clocks are made, as if by a natural local growth, at Terryville; cheap jewelry, at Attleboro'; and so on.

It is by the operation of this law of aggregation that the business of manufacturing collars and cuffs, along with one or two other closely related occupations, has grown up at Troy, New York, where about eighteen firms, some of them quite wealthy, and all energetic, are established in this one business. It is proposed in this paper to describe the organization and operations of one of these firms — that of George B. Cluett, Brother & Co. — as an illustration at once of the actual extent and importance of the demand for articles seemingly of trifling significance, of the surprising investment of money and inventive talent, and the astonishing complexity of the operations that are carried on, in order to produce goods which shall suit the increasing fastidiousness of customers about style and workmanship, which shall at the same time not cost too much for the average purse of the citizen, and which shall nevertheless afford to the manufacturer a just compensation for his time, labor, and talents.

The wife or mother who sits down to finish off the wardrobe of one of her "men folks" with half a dozen collars, has a simple task to perform. She measures the neck, and receives, or should receive, a kiss for her trouble; or takes the measure from a shirt,

or an old collar. If the latter, she has a pattern all ready; if the former, she cuts out a paper pattern, by memory, or by judgment, or by hap-hazard. Then she cuts the linen for the bands and the collar-pieces, bastes them, sews them, makes the button-holes, rinses them, starches them, rough-dries them, sprinkles them, irons them, and it is done.

At the very furthest opposite extremity of the scale of industrial establishments from this solitary needlewoman, stands a great factory like that of George B. Cluett, Brother & Co., with its dozen of great rooms, each occupied by the hands busied in one special stage of the manufacture; its hundreds of outside hands, all checked and organized, to carry the work through certain stages; its lofty, airy sewing room, with a hundred clattering sewing machines, driven by steam; its departmental laundry, supervised by a practical chemist and inventor; its extensive depot of goods ready for the market; and its endless, innumerable mass of daily accumulations, that, if whirled abroad upon the air before some tempest employed for the purpose, would whiten a whole country with a linen snow-storm of tens of thousands of flakes, in cuffs, and wristlets, and collars, and fronts, and habits for ladies and gentlemen, of every imaginable pattern, at the rate of acres per day.

Not the least important era in the history of a collar is that before it exists. Suppose, for instance, you buy in September a new supply of collars, of the newest fall style, from the manufactory of Messrs. George B. Cluett, Brother & Co. If the processes attending the development of this style went through a usual course, that course began in June, in the brain of Mr. Cluett, or of one of his three brothers, or perhaps of one of their employés, and began with an idea. This was the idea of a collar, to be in one way or another improved upon, or varied from, the current styles. Perhaps it is to be broader in the band; or rounded in front; or with sharp points in front; or with points turned down; or sloped off at the tie at a wide angle, or at a narrow angle; or stitched with a new arrangement of the lining; or with a new device for securing clean, sharp corners; and so on.

Well: this idea grows and develops until it is complete enough to be embodied in a pattern; and if it is considered likely to please the public, the next question is, How much cloth will it waste? This is ascertained by trying the pattern on the width of the cloth; and it is accepted, modified, or rejected, as may be re-

GEO. B. CLUETT, BROTHER & CO'S LINEN COLLAR MANUFACTORY, TROY, N. Y.

quired. This being decided, from twenty to thirty pieces of wood have next to be fashioned — being the working patterns which the cutters use in shaping the pieces from the cloth ready for sewing. The number is fixed as follows: One wooden pattern gives the form of the band, and another of the collar. But necks are not all of the same size. Practically, men's necks are from twelve and a half to eighteen inches round, and women's from ten to sixteen and a half inches, though extra sizes are sometimes furnished to order as far as to twenty-one inches. It is found that a scale of half-inch differences is best between these extremes; so that, for the band of the supposed new style of collar, there must be a separate wooden pattern for the $12\frac{1}{2}$-inch, 13-inch, $13\frac{1}{2}$-inch, and so on, up to eighteen inches, being, in this instance, — which is an average one, — twelve patterns. Twelve patterns more to match these are also made for the collar part. These patterns are cut out of carefully seasoned thin boards of maple wood.

Next comes the cutting. For this purpose, a whole piece of cloth, or even more, is carefully laid out, even and smooth, on the cutting-board, which is a thick plank of white pine. This wood blunts the knives less than any other; and when the surface is roughened and crumbled under the innumerable knife-strokes, it is planed down to a new, clean stratum again. The cloth is laid forty-eight thick; and a number of heavy bell shaped masses of iron, like large paper weights, are placed on it to keep it in place. The knives used have short blades, somewhat after the style of a small, short shoe-knife, and the blade is separate, fastening into the handle while in use with a small set screw. There is one single blacksmith in Troy who possesses exclusively the secret of giving to these knives exactly the right temper to go through forty-eight thicknesses of linen with the least possible trouble. He keeps his secret, like the legendary forgers of fairy blades in the old stories of chivalry, and makes a very good thing of it.

Having thus been cut out, the pieces are put together in little parcels, each containing the materials for a dozen collars, and the family thus formed remains together through all the subsequent vicissitudes of its youth in the factories, until, having, as it were, grown up to maturity, it is dispersed abroad into the great world, each member to shift for itself; i. e., it goes into the hands of a customer, to be retailed or worn out.

The successive operations which now follow are these: The collars having been (1) cut, are (2) run, (3) turned, (4) stitched,

(5) bands run over, (6) bands turned, (7) bands stitched, (8) button-holes cut, (9) button-holes worked. Of these operations, some parts are done by outside hands, but most of them in the factory. All the rooms of Messrs. Cluett Bros. & Co.'s building are unusually light, airy, and well ventilated; and their sewing-machine room in particular, which was formerly a public hall, is a remarkably lofty and airy room. The balcony which the fiddlers used to occupy is still there, but the innumerable sharp chatter of a hundred sewing machines fills the room with a noise that leaves no place for other music, and the vibration of the needles beats the speed of a fiddler's elbow quite out of sight.

The machines are arranged in rows across the room, and each is belted to a shaft that runs along the floor and supplies the necessary power. This arrangement wholly obviates the well-known serious objections to sewing-machine work by treadle power. The day's work of each machine is equal to what could be done by at least twenty women, and the hundred together therefore constitute a working force equal to two thousand sewing-women without machines. An extreme estimate would add another thousand to this total.

When all these sewing processes are at last complete, the collars — and so of other articles, for we are following the fortunes of the collar as a representative of the rest — are transferred to the laundry, where a second series of eleven processes is gone through with, besides the mere transfer. These are as follows: (1) Washing in suds, to remove the manufacturer's "dressing" from the goods; (2) bleaching, by means of hyperchloride of soda; (3) application of dilute sulphuric acid, to complete the bleaching process; (4) washing in suds, to remove the acid; (5) boiling; (6) rubbing and rinsing; (7) bluing and rolling; (8) starching with thin starch; (9) starching with thick starch; (10) drying; (11) ironing.

These operations are greatly facilitated by the arrangement and fitting up of the different rooms, and by various devices for economizing labor and power. Thus a peculiar formation of the stove for heating irons keeps forty of them hot all the time, with a small average consumption of coal; the order of the tubs used is such as to make the progress of the goods easy through the successive processes, etc. The starch used is not of wheat, but of corn, which is found to be equally efficient, cheaper, and much less disagreeable to the fingers of the operatives. This is a pretty important

consideration, for it is found to make the difference between sore fingers and healthy ones, — that is, work or idleness, — besides pain, which is sometimes no small item, as the very agonizing local inflammation called felon has occasionally been somewhat frequent among those who work in the starching rooms.

After the ironing, each family of a dozen collars is once more assembled, and carried to the inspecting department. A system of inspection is, however, maintained throughout all the works; and it is necessary to use a good deal of strictness in order to prevent the destruction of much valuable property by careless making up. This final inspection, however, decides upon the quality of the completed goods as adapted for the market, and upon passing, each separate article is stamped with the name of its style, and size, after which the dozen is enshrined in its neat paper box, there to remain until sold to the consumer. The firm formerly packed in larger single parcels; but the convenience of trade has made it an invariable rule to pack everything by single dozens, and the dozen is accordingly the sole ultimate numeral standard of the business, no smaller or larger number of any article being packed in one paper box.

The finished goods sent to market by Messrs. George B. Cluett, Brother & Co., being thus thought out and adapted in advance of the demand, are accumulated, according to the practice of the firm, to a very considerable extent. It is not unusual for them to have on hand thirty thousand dozen or more of articles all ready for use, each having gone through the whole series of twenty processes that have been described, and representing, of course, a very large sum of money paid out for materials and labor.

Moreover, this forethought in determining styles must be successful, or the result must be a serious loss to the firm. No moderate number of collars, for instance, can be made up at once and sent out as specimens, with the expectation of manufacturing to fill orders if the new style suits. There will not be time for that; for there are plenty of rival houses ready to snatch after any good new idea, and who do, in fact, do so as it is; so that the chief advantage which this shrewd and wide-awake firm can reap from their good judgment and invention, depends upon their running the risk of success. They therefore take it for granted that each new style will succeed. In sporting language, they "back themselves heavily every time." The result justifies this bold practice; for hitherto, with unimportant exceptions, the large stocks which

they have ventured to make up on this principle have enabled them to constantly keep in advance of their competitors, notwithstanding the unfair as well as fair efforts of others in the same business. Cases have been known, indeed, of a systematic boast that such a one would keep up with all of Cluetts' new styles, and have them in the market as soon as they, which is very much as if a parasite insect should boast that his blood was as good as that of the man he sucked it from. Such boasts have been in some measure accomplished, too, by secret espionage among the hands, and similar methods, but as yet without any signs that this parasitic method is materially injuring either the invention, the temper, or the pocket of George B. Cluett, Brother & Co.

This firm, on the contrary, is well satisfied with that sort of success which is the only really desirable one in business — honest gains from enterprise, industry, and fair dealing. Steady kindness, and at the same time as much strictness as is necessary, keep them popular with their hands, of whom they employ from five hundred to eight hundred. This treatment, and the pleasant quarters afforded to their operatives, secure the important advantage of steady help. Some of those in the establishment have been with the firm for twelve years or more; and it has repeatedly happened that those who left, for one or another reason, have returned and asked to be employed again, having found neither their new employers nor their new quarters as comfortable. This amicable state of things does not, however, prevent a strenuous adherence to their rights. A few years ago, a so-called "Working-women's Union" was set up among the hands, and at once went to work to raise wages. Apparently there was a measure of justification for the step, since the required advance was granted, as was another within a few months. A third, however, met with a prompt refusal; the manufacturers, though not organizing into any formal body, agreed to put a stop to the performances, the Messrs. Cluett being among the very first in taking this ground. The demand of the "Union" was peremptorily refused, work stopped, the ill-advised strikers were let alone until they returned to work at previous rates, and the Union was exterminated, as no member of it would be employed.

There are some noticeable differences between men's goods and women's goods as they appear in a large house like that of George B. Cluett, Brother & Co. Women's collars, cuffs, etc., very properly admit of much more ornament, both in form and finish, than is

allowable on men's goods, and, accordingly, they cost decidedly more per article. On the other hand, the ladies' goods do not have to be made and put up with nearly so much accuracy in respect to length by inches and halves, etc., as the pin method of fastening, and ladies' ways of finishing with a bow of ribbon or the like, render it easier to fit them.

It is curious to see how much and how effective ornament can be put on work turned out in the wholesale style of this firm. Insertion, cords, plain and colored stripes, dots, edgings, embroideries of many kinds, besides the endless varieties of graceful outline, are used on the collars, cuffs, under-sleeves, habits, etc., of the ladies' goods department, affording, of course, a much wider field for the inventive and artistic faculties of the firm than the comparatively monotonous and plain goods which are "good enough for the men."

This house, which offers so admirable an instance of how readily the American business world adapts itself to new conditions, and turns them to its own uses, is composed of four brothers, whose names may well be given here in full, as belonging to the history of American industry: George B. Cluett, J. W. Alfred Cluett, Robert Cluett, Edmund Cluett.

BROAD AND NARROW GAUGE RAILROAD CARS.

TRANSPORTATION, TRAVEL, AND COMMUNICATION OF THOUGHT, AS POLITICAL INFLUENCES. — ELEMENTS OF SUCCESSFUL RAILROAD OPERATION. — IMMENSE NUMBER OF RAILROAD CARS MADE IN THE UNITED STATES. — QUANTITY OF WORK ON ONE CAR. — AMERICAN AND ENGLISH STYLES OF PASSENGER CARS. — WILMINGTON MAKES MORE RAILROAD CARS THAN ANY OTHER OF OUR CITIES. — LOCATION OF JACKSON AND SHARP CO.'S DELAWARE CAR WORKS. — ARRANGEMENT OF THEIR BUILDINGS. — LUMBER-YARD AND MODE OF SEASONING. — HISTORY OF THE CONSTRUCTION OF A CAR. — TIME USED. — "LIFE" OF A CAR. — WEIGHT AND COST OF CARS. — NUMBER OF TRADES CONCERNED IN A CAR. — JACKSON AND SHARP CO.'S SHIPYARD AND MARINE RAILWAY. — THE NARROW-GAUGE SYSTEM. — ORIGIN AND PROGRESS. — NARROW-GAUGE PASSENGER CARS DESCRIBED. — ANALYSIS OF THE ECONOMY AND ADVANTAGES OF THE NARROW-GAUGE SYSTEM. — LEGALLY UNIFORM THREE-FOOT GAUGE RECOMMENDED.

THERE is an important political necessity for ease, speed, safety, cheapness, and comfort in travel, transportation, and communication of thought. The two former are the circulation, the last is the nervous system of the body politic. A rope long enough will break by its own weight. It is a well-known truth in Zoölogy, that an animal whose size should be extravagant would become a mechanical absurdity. Its materials, like those of the rope, would be unable to withstand the effects of gravitation, and the creature would break down — would smash, in fact — from its own weight. If, however, we imagine the density and hardness of the bones, skin, muscle, and other tissues greatly increased, the circulation made very powerful, and the supply of nervous energy increased until the distant parts of the great frame are as swiftly and surely supplied as those of a small one, in that case the organism might exist. A cow must be on an average of denser texture and harder than a mouse, and an elephant than a cow. Giants have always been represented as stupid and clumsy; it is very frequently the case that small men are swift in movement, and brilliant in thought and action.

It is steam and electro-magnetism that make so large a single country as the United States possible. With no other means of intercommunication than existed at the time of the Revolution, our present existence would be mechanically out of the question. The Pacific

States, for instance, would not endure the authority of a government seated at the extremest opposite verge of a continent, distant by a tenth of the earth's whole circumference, and at the end of a land journey of certainly not less than six months, and very likely entirely impracticable; or of a sea voyage of not far from the same length around Cape Horn. It is because we can travel between Washington and San Francisco in a few days, and can communicate between them in a few seconds, that our country still extends from ocean to ocean.

Within that vast railroad organism, which this figurative representation takes as a circulating system in the United States, there may be further distinguished several elements. Thus, we find that speed depends upon the excellence of the road, locomotives, and trucks. Cheapness and safety depend upon the judgment, skill, and honesty employed in construction, equipment, and operation. But comfort and convenience, which are not much, if at all, less important in promoting travel and attracting patronage, are chiefly dependent upon the structure and details of Railroad Cars.

The extent of business transacted in providing for this single department of one of the several business interests concerned in promoting the sole purpose of land transportation is enormous. How enormous, it would take a long compilation of figures, and considerable labor in statement and in understanding, to fully realize. But there are somewhere about two thousand railroads in operation in the United States; of these, one single one owns more than sixteen thousand cars, including all kinds; others have between nine and ten thousand; and quite a number as many as five or six thousand. These have to be frequently renewed, for a car lasts certainly not more than nine years on an average. And new roads are coming into operation at the rate of over two thousand miles a year, all requiring complete new outfits. Cars cost from $ 600, which will buy a "flat" or platform car, up to $ 20,000, which is the cost of one of those gorgeous travelling hotels called "Palace Cars." It is evident that the quantity of capital invested in car manufacturing alone must be very great. To represent intelligibly the quantity of work invested, would be still more difficult, whether the number of hands employed, or the number of days' work represented by each completed car, or the quantity of materials and number of separate pieces in a single car, should be adopted as a criterion. For instance, there were counted on one side of one car, standing half finished in the Jackson and Sharp Company's Works, at Wilmington, 183 wooden pegs, 408 brads, 288 nails, and 132 pieces of wood. This included only one side of the wooden

skeleton of the car, not including floor, top, or ends, trucks or roof, nor seats, upholstering, fitting, and finishing. A memorandum hung up near by showed that 576 bolts and other iron fastenings (not counting screws, nails, brads, tacks, &c.) had been called for for two cars. This makes 1,299 articles used for much less than half the items of a complete car. Indeed, it would take a day to inquire out, note down, and compute the whole number of single parts and pieces that go to make up that marvel of strength, lightness, and endurance, called a Railroad Car.

The present American style of railway passenger coach is a natural and legitimate product of American ideas. Few know how greatly it differs from the passenger vehicle of the first railroads, which is still substantially the model of the English roads. It may be described as the democratic palace instead of a nest of aristocratic closets. The first railway coaches retained the arrangements, as they did the name, of the stage-coaches they have superseded. They were simply a coach body placed on a four-wheeled truck, with room for six inside, and with a seat for one more passenger projecting outside at each end, as if to secure a pair of human "buffers" between each two cars. This plan was soon varied by building one car of capacity equivalent to several coach-bodies, and divided into compartments with two transverse seats in each, while the conductor climbed along a foot-board outside. The English and European cars are still built on this plan, whose seclusion and difficulty of access have repeatedly been made use of for perpetrating robberies and murders, as there is no practical and prompt mode of attracting the attention of other passengers or of the conductor.

The present or American car effectually prevents any danger from criminal violence, while the bell-cord which runs through the train — an American device, coming slowly into use in Europe — affords an almost certain means of notifying both conductor and engineer of any emergency out of the regular order of events. While on this point it may be added that American inventors have also introduced the swinging truck, to meet the requirements of the short curves of our railroads; a separate baggage car, instead of piling the baggage along the roofs of the passenger coaches; and the mode of warming by a stove. English cars are warmed, if at all, by boxes of hot water set in the compartments.

Many other points of improvement, both in general and in detail, might be mentioned. The last result of them all, the so-called

"Palace Cars," illustrates almost as strikingly as our great hotels do the curious tendency to accumulate in accommodations for the public luxuries, or at least showy trappings, greatly beyond what most travellers enjoy or would enjoy at home.

More railroad cars are manufactured at Wilmington, Delaware, than in any other city of the United States. Some account of one of the more extensive and complete car manufactories of that place, the Delaware Car Works, belonging to the Jackson and Sharp Company, will consequently afford a fair idea of the scale on which the business is conducted, and the outlines of its organization and management.

The Jackson and Sharp Company's works stand on a tract of about eight acres of land, very conveniently situated, the track of the Philadelphia, Wilmington, and Baltimore Railroad passing across their front line, while Christiana River bounds them on one side, and Brandywine River on the other, — an arrangement which affords them singular facilities for transportation, both by land and water.

The buildings of the Company have been erected on purpose for their business, and are arranged in a very convenient manner to accommodate their car-building business, an extensive sash, door, and blind business which they carry on at the same time, and certain parts of their shipyard and marine railway business. Outside of the buildings themselves a large area is occupied with great piles of lumber, amounting in the aggregate to over 1,000,000 feet, passing through the seasoning process, — a peculiarly necessary one in this business, as the enormous strain on the frames of railroad cars makes it absolutely necessary that they should be made of the best materials, prepared in the best manner. This lumber-yard indeed is quite extensive enough of itself for a very handsome lumber business, without any of the other departments.

The seasoning often occupies a year or more, and is very carefully watched, the piles of lumber being laid in a kind of open order, with the ends toward the prevailing winds, so as to get all the drying that the air can give. For cabinet work, of course, the wood is kiln-dried in addition.

The history of making a car is somewhat as follows: When ready for use the lumber is hauled into the planing-mill, a roomy and thoroughly furnished department, where it is planed and sawed to the right dimensions. Next is the setting-up room, where is performed a process of laying the sills, framing up, and covering in, which is about half-way between ship-building and house-building;

When the wood-work is complete the car goes to the painting-room, where it receives a long course of treatment, one coat after another of paint, to the number of six, being laid on, left to dry into the wood, and rubbed off, until a proper surface is prepared for the three coats of varnish which form the last finish, much of which is of the same transparent and wonderfully brilliant surface that most of us have admired so much on a piano. In this painting-room great pains have to be taken to keep the temperature at an even warmth, and it is never allowed to fall below sixty-five degrees.

After the painting comes the upholstering. The seats have been made in the cabinet shop, the cushions, &c. prepared, and they are now put in place and screwed down. The frescoed cloth, whose graceful designs look so prettily on the roof, has also been made ready in a roomy loft occupied for the purpose by a force of skilful decorative painters. It was in this establishment that this branch of the car-manufacturing business was first introduced. Their operations have an aspect that reminds one of the old-fashioned "quilting-frames," each piece of cloth being stretched for the purpose of painting on a wooden frame, which, however, stands edgeways before the workman, instead of lying horizontally on four chairs.

The trucks have also been made in their separate shop. They are now brought up, and the car, hitherto moved about on temporary trucks, mounted on them; and it trundles out of the front shop upon a side-track from the railroad, all complete and shining, and ready for its purchaser.

The disposition of the various buildings through which the car has passed is such that, from the lumber pile into the planing-mill, and thence to where the completed car rolls out of the door upon the railroad track, it describes a course somewhat like that of an enormous letter S, moving forward through one long building, back through a second, and forward again through a third. The whole time occupied has been about two months, a large part of it being taken up by the slow drying of the different coats of paint. The whole distance thus moved has been about 1,600 feet, or 800 feet a month, which comes to about half a car's length a day. A well-made car, carefully used, its bolts and fastenings watched and "turned up" from time to time, and repairs made when needed, would last twenty or even thirty years. In practice, however, the life of a car is not, on an average, much more than nine years. The works of the Company are extensive enough to enable them to have fifty or sixty cars in process of manufacture at a time.

JACKSO I & SHARP CO. CAR WORKS, WILMINGTON, DEL.

The following little table shows the approximate weight and cost of different styles of cars: —

Designation of Car.	Weight, lbs.	Cost.
Pullman	56,000	$12,000 to 20,000
Passenger	39,000	5,000 " 6,000
Do. 2d class . . .	35,000	3,000 " 4,000
Freight (box)	16,000	700 " 800
Flat or platform	12,000	550 " 650

The number of different kinds of materials used, and of different trades employed, in completing an ordinary passenger car is surprising. For instance, the sills and plates and the floor are made of yellow pine; the posts of the frame, of ash; the bolsters and the truck frames, of oak; the sheathing, of white-wood, and the roof, of white pine and cypress,—being seven varieties of wood, besides the cherry, black walnut, and other ornamental woods commonly used for the inside ornamental work. As for the different cloths, plush, tacks, nails, screws, hinges, catches, locks, and small hardware, and other upholstery and metal goods, there are too many to enumerate. And the tradesmen and mechanics who must have a hand in finishing the elaborate structure are as follow; a complete list would reach fifty in number, or thereabouts: —

Car Builder,	Spring-maker,	China dealer,	Varnisher,
Sawyer,	Seat-maker,	Glazier,	Carpet-maker,
Carpenter,	Pattern-maker,	Gilder,	Plush-maker,
Joiner,	Upholsterer,	Tinman,	Silk manufacturer,
Cabinet-maker,	Hardware man,	Electro-plater,	Cotton "
Turner,	Glue-maker,	Rubber manuf.,	Woollen "
Veneerer,	Lamp-maker,	Engraver,	Thread "
Carver,	Stove-maker,	Chaser,	Oil Cloth "
Machinist,	Plumber,	Painter,	Trimming "
Blacksmith,	Ventilator dealer,	Fresco painter,	Oilman,
Iron Founder,	Steam-pipe fitter,	Letterer,	Laborer.
Brass Founder,	Wheel-maker,	Axle-maker,	

The great strength and accuracy of workmanship, and peculiar style of framing and fastening required, are much alike in car-building and ship-building. The peculiarly convenient location of the Delaware Car Works in connection with this similarity, together with the ease with which good ship timber can be delivered on the premises from a very great extent of country both by land and water carriage, very naturally determined the establishment of a shipyard in connection with the car factory. This is fully supplied with all

the requisites for its business, and commands a fair share of it. The works offer unusual conveniences, particularly for repairing vessels, having a well-furnished marine railway, on which any vessel, not exceeding twelve feet draft of water, can be hauled up high and dry, repaired to any desired extent, and slid easily back into the water. A train of powerful but simple wheels driven by a steam-engine operates the large endless chain that hauls the cradle of this railway; and the suit of tools, machinery, and materials of all kinds for repair work is very full and efficient. One great advantage possessed by the Works is the abundant steam power, which can be used at pleasure in any department. Thus, not only is steam power economically used in operating the marine railway, and in running the other machinery of the Works, but it is applied with great efficiency to the sawing and planing machines in the saw-mill, and to a peculiar and valuable suit of saws used in cutting out and shaping ship timber of all kinds, one machine being capable of dealing with timbers sixty feet long.

This account of the Delaware Car Works and their operations would be quite imperfect without some reference to their Narrow-Gauge Freight and Passenger Car business, in which they are the pioneer manufacturers on the Western Continent. The Narrow-Gauge principle, indeed, although in this country it has barely begun its career, is already causing a change in railroad business almost great enough to be called revolution. It was first thoroughly "proved up" on the Festiniog Railway in Wales, under the management of Mr. C. E. Spooner, who may be called the father of the narrow-gauge railroad. It was next introduced by Carl Phil, a Norwegian engineer, into Norway. It was rapidly adopted for a number from among the network of railroads with which the English are opening up the vast and rich interior of their Indian empire, in Russia, Australia, and South America, and in Canada and the United States. Narrow-gauge roads are already either in operation or in rapid course of construction in Colorado, Arkansas, Texas, Utah, Georgia, New York, Ohio, Missouri, Illinois, and Iowa, while many others are in contemplation. It is an unaccountable circumstance, by the way, that in "Poor's Manual of the Railroads of the United States for 1871–2," which pretends to give a "Sketch of the Railroads of the United Statts," there is not even a hint that there exists a narrow-gauge system or road. This is much as if Mr. Poor should publish a History of Transportation without referring to steam-engines.

But the Narrow-Gauge system will very quickly make its own

history, with or without any recording angel, as the Jackson and Sharp Company have excellent reason to know ; for they are not only the first, and up to this time the only builders in the country of narrow-gauge passenger and freight cars, but they are already filling, or have filled, contracts for such cars for eleven or more different roads. One order, for a train of cars for the Denver and Rio Grande Railway, has been filled, and the cars, including two passenger cars, two smoking cars, and two baggage and mail cars, the first ever constructed in America, were delivered at Denver August 2, 1871, in eighteen days from Wilmington, attracting great attention and praise from railroad men and others wherever they passed. These passenger cars are 35 feet long, 7 wide, and 10½ high. They weigh 15,000 pounds each, and carry 36 passengers, being 416 pounds of car for each passenger, while the ordinary car, carrying 54 passengers, weighs 39,000 pounds, or 722 pounds per head. The seats are double on one side and single on the other, with one alternation in the centre, so as to maintain a balance of weight when full. Except in these points of size and arrangement, they correspond to other elegantly finished passenger cars. The sills of these cars are only 27 inches from the ground, the usual height being 45 inches; a difference which lowers the centre of gravity so much that the narrow-gauge cars are less liable to be overset than the broad ones. The "angle of stability," as it is called, for the cars, empty and loaded, is 50½ degrees and 47½ degrees respectively ; figures which demonstrate to the railroad mechanic a remarkably broad base for the car while in motion.

These cars have been drawn at a speed of forty miles per hour by locomotives (built at the celebrated "Baldwin Works" of Philadelphia), and have encountered gales whose severity is too well known to travellers in the Colorado Uplands; in fact no effort has been spared to put them to the severest test. Their success under such circumstances fully insures their future performance, and demonstrates that the gloomy doubts entertained by many minds, respecting narrow-gauge rolling stock, were utterly without foundation, and worthy only of a past age.

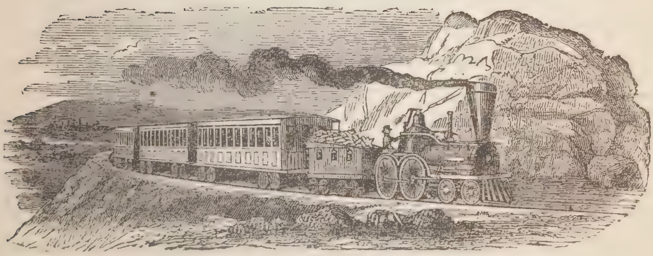
It is easy to show how immense a saving can be made by the use of the narrow-gauge. This system, to begin with, saves in respect to all the heavier work of grading, embanking, tunnelling, &c., an important proportion of land damages; half the expense of rails (which weigh 30 pounds per yard instead of 60) ; besides that shorter curves can be used, which makes the engineering part of railroad

work both easier and cheaper; so that roads built on this principle cost about five eighths the expense of broad-gauge roads. About one third of the cost of fares and freights is saved, from the small cost of hauling. This results, in great measure, from the gain in strength on smaller cars, in consequence of which, on the narrow-gauge road, one ton of freight car will carry one ton of freight, while on the broad gauge for every ton of freight there is hauled $2\frac{68}{100}$ tons of car. The saving on passenger car, dead weight, being about 300 pounds per passenger, or over 30,000 pounds for each hundred passengers, has been mentioned. An equal degree of speed is attainable, and greater safety; and from the shortness of the axles the wheels slip less on the outer sides of curves. This diminishes the consequent twisting force applied to the axles, which is known as the "torsion strain," which, as is well known, destroys the fibre of the iron, makes all car-axles useless after a time, and causes numerous railway accidents. Lastly, this cheapness of construction and operation renders railroads attainable in many districts which are not rich enough to afford the cost of a broad-gauge road.

General W. S. Rosecrans, in a recent letter on the subject of narrow-gauge railroads, goes into some interesting calculations, which show that if the railroads of the United States, down to the end of 1867, had been built on the narrow gauge, the saving in first cost would have been $ 480,000,000; the annual interest of which is, at six per cent, $28,800,000; that the annual saving on haulage would be $ 100,800,000,—in all an annual saving to the people of the United States of $ 129,600,000. He shows, further, that a much greater saving is in question for the future; for, he reasons, provided the whole country is to be as well furnished with railroads as the State of Ohio, there will be a total length of 165,800 miles of railroads; and the annual saving on this length of roads on the narrow-gauge system would be $ 547,540,515; which would pay off our present national debt in about five years. Moreover, he shows that railroads, on the average, add ten dollars an acre to the value of lands within ten miles of them; the narrow-gauge roads can be afforded in districts where broad-gauge roads could not, to an extent which it is moderate to call 30,000 miles; which would add to the value of the land bordering these roads $ 3,800,000.

Even if we subtract a large margin from these figures to allow for speculative estimates, the remainder demonstrates a saving in money so monstrous that it is actually scarcely within our comprehension.

Before dismissing this interesting subject, it is worth while to direct attention to one point, — *a legal uniformity of gauge.* Some thirty or forty different gauges have been used for railroads, from seven feet down. A variety of narrow gauges has already begun to be introduced in other parts of the world, and will naturally be used in our own country unless an effort is made to prevent it. It is unnecessary to show what immense advantages would arise from an absolute uniformity in the gauge of all railroad lines, in respect of ease and cheapness of travel and transportation. Engineering authorities of the first rank have settled that a three-foot gauge is the best for practical purposes. The State of Massachusetts has actually by law provided that this shall be the width of all narrow-gauge roads within her borders. It would be a great gain to the public if all other States who shall charter narrow-gauge railroads would do so upon this express condition.



HAIR CLOTH.

EARLY MANUFACTURE IN THE UNITED STATES. — TAURINE CLOTH. — HORSE HAIR CLOTH. — SOURCES OF SUPPLY. — SIBERIAN AND SOUTH AMERICAN HAIR. — PROCESSES OF MANUFACTURE. — CLEANSING, ASSORTING, AND DYEING. — INGENIOUS POWER LOOMS. — ISAAC LINDSLEY. — OLD PROCESSES. — INSPECTION, TRIMMING, AND PACKING. — WIDTHS, DESCRIPTIONS, AND PRICES. — AMOUNT OF MANUFACTURE.

THE beginning of the hair cloth manufacture in the United States was at Rahway, New Jersey, in 1813, by two New York patentees, for a process of making what was called Taurine cloth and carpets, — coarse fabrics from the hair of cattle, with a mixture of wool, — and the business was profitably pursued for several years. In 1835 there were two horse hair cloth manufactories in the country; but until within a few years past nearly all the hair cloth used in the United States was imported, and was employed almost wholly in covering furniture.

The sources of supply for horse hair are Siberia, which furnishes two thirds of the amount, South America, which gives one fourth, and the rest is collected in other countries. The hair is cut almost wholly from the tails of horses, and what is collected in Tartary, Siberia, and the Russian possessions is brought for sale to Tobosk, Siberia, where there is an annual fair, in which horse hair is an important article of merchandise.

The hair is assorted in lengths of from eighteen inches to forty inches, and is packed in bundles two and one half inches in diameter, weighing about four pounds each, and costing, according to quality, from sixty-five cents to three dollars and seventy-five cents a pound, "quality" relating almost exclusively to length, and the longest hairs bringing the largest prices. The long white hairs are used for fiddle-bows, though the dark hairs can be bleached, and subsequently dyed of any color; the long black and gray

hairs are dyed black, and are employed in cloth-making; the medium lengths are woven into small sieves, strainers, filtering-bags, gloves, mittens, etc.; the short hairs are curled for stuffing for furniture seats, arms, and backs, and for mattresses; and the shortest are made into brushes.

Processes of Manufacture.

The hair comes to the manufactory in bags, containing from one hundred to three hundred pounds, and of all shades — black, brown, gray, and white — the black predominating. If it arrives in a rough state, it is first cleansed and assorted. After assortment, the hair for cloth, even the black, is put into steam-heated coloring matter in vats, where it remains from one to two hours, and receives a perfectly black color, which will not fade. Previous to dyeing, all the animal matter is removed by allowing the hair to lie twelve hours, or all night, in a solution of soft soap. After dyeing and drying, the hair is hackled and assorted by machinery into nearly uniform lengths, is put up in bundles of about one fourth of a pound each, and is "squared," that is, the ends are cut off to give uniform length for weaving.

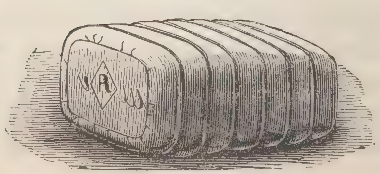
In one manufactory in this country there are three hundred and eighty-seven power looms, to the use of which this company has the exclusive right. The inventions for feeding the hair and regulating the machinery are exceedingly ingenious, and one girl can attend to ten looms. The warp is black cotton thread, and the general process is like that of weaving ordinary cloth, only, instead of placing the hair, as in the woof of wool and cotton fabrics, on bobbins, and thrusting it through the warp on a shuttle, it is placed on an arm of the weaving-beam, with its squared ends so presented that the "needle device," or "pick-up," lifts a hair to the "nipper-stick," which catches it, and shoots through the warp at the rate of fifty times a minute. If in any instance the needle device fails, the whole process of weaving is instantly stopped, as the machinery works, or ceases to work, automatically.

This ingenious power loom costs about two hundred dollars, and is the invention of Mr. Isaac Lindsley, of Pawtucket, R. I., who has invented other valuable machinery. The process of picking up the hair by machinery is pronounced by the *Encyclopedia Britannica* to be an "impossibility," and that long after Mr. Lindsley's invention was in successful operation. Before the invention of

the power loom for this kind of weaving, hand looms, each requiring the attendance of two girls, were used, and the hairs were furnished one at a time to the weaver by a girl, or child, who threw the hair over the hook of the shuttle for the weaver to draw through. Now one girl attends ten looms.

After weaving, the cloth is thoroughly inspected, points or broken hairs are cut off, and other slight defects are remedied. It is then trimmed by machinery, which cuts off all excrescences, and smooths it. This was formerly done by hand, it costing a dollar to trim a piece, while by machinery the cost is only eight cents a piece, and thirty pieces can be trimmed in ten hours. The fabric is finally hot calendered, to give it a fine lustre; it is subjected to tremendous pressure by hydraulic power, to make the cloth keep its finish, and to prevent it from rising up when it is dampened, and is then packed for market. The width regulates the price, and the widest and highest priced is about forty inches.

The probable amount manufactured annually in the United States is about six hundred thousand yards, varying in price, at wholesale, from fifty cents to two dollars and eighty-five cents per yard, or say an average of one dollar per yard. The different descriptions are "hair-seating" for upholstering chairs and sofas, "padding" for tailors, and "skirtings," or "crinoline."



FURS AND THE FUR TRADE.

THE TERM "FUR." — THE EARLY USE OF SKINS FOR CLOTHING. — THE TRADE BEFORE THE DISCOVERY OF AMERICA. — THE FRENCH IN CANADA. — THE "COUREURS DES BOIS." — THE HUDSON BAY COMPANY. — THE NORTH-WEST COMPANY. — OTHER COMPANIES. — J. J. ASTOR AND THE AMERICAN FUR COMPANY. — THE VALUE OF THE TRADE IN FURS. — THE VARIETY OF ANIMALS WHOSE SKINS ARE USED.

THE term "fur" is generally applied to the skins which are dressed with the fur on, of certain animals found on the land or water of cold countries. Before these skins are prepared for use, they are known in trade as "peltry." As these skins, when softened by proper dressing, possess the qualities of warmth, durability, and beauty, it was natural that they should be employed as clothing, for comfort and protection in cold climates. In fact we find that from the earliest time garments made of the skins of animals have been used for clothing — in warm countries, the hairy skins, and in cold countries, the fine and soft furs. In the religious traditions of most nations, the first clothing used is thus represented to have been "coats of skins." In reference to this fact, it has been quaintly observed, "Clothes came in with sin; little reason have we, therefore, to be proud of our clothes, which are but the badges of our poverty and infamy." Yet these traditions of the advent of sin, like that of the custom of wearing clothes, are simply the traditions of an ignorant time, made before the knowledge in the world was sufficient to arrive at any generalization competent to account for the position of mankind in the hierarchy of nature.

The heroes of classic story are represented as wearing the skins of animals — Æneas in a lion's skin, and Alcestes in that of a rough Libyan bear. Virgil may have drawn on his imagination for his facts, since Pliny asserts that no bears are to be found in Africa, because the climate is too hot for them. Not only the Scythians and

other rude people known to the Romans as barbarians, were clothed in skins, but choice furs were the ornament and luxury of senators and kings. As early as the eleventh century furs became fashionable throughout Europe, and dresses of costly furs were seen in the courts of royalty. Louis IX. required for the lining of one of his garments seven hundred and forty-six ermines. In the fourteenth century, Edward III. prohibited the use of furs to all persons whose income did not exceed one hundred pounds a year.

At a very early period, furs in northern countries constituted the wealth of the people, and valuable skins were used as currency in payment of debts, and in commercial exchanges with other countries. When the Russians took possession of Siberia, they received tribute in furs. A similar condition of things existed in some of our Western states, if we accept as history the old song:—

> "General Jackson! Who is he?
> They say he lives in Tennessee;
> But Tennessee is no great things,—
> She pays her debts in raccoon skins."

The trade in furs was carried on extensively in Western Europe by the Hansards,—merchants belonging to the Hanseatic League,—who occupied the towns on the southern shores of the Baltic Sea. Later, an English company was formed, by which a direct trade was established between England and Russia, the company being protected and encouraged by the Russian emperor. This company had posts on the White Sea, and sent trading parties into distant regions, both for buying and selling peltry. The choicest furs in these times were appropriated by the princes and nobles of Russia, Turkey, and Persia. They often constituted the gifts of royalty to kings and others favored or honored by them. The Emperor of Russia sent presents of costly furs to Queen Mary and to Queen Elizabeth; but the Virgin Queen soon after interdicted the wearing of any but native furs, which so interfered with the trade that it declined and was abandoned.

The French, who at an early period established themselves in the northern parts of North America, very soon discovered the value of the fur-producing animals found in the rivers and forests of those extensive regions. They found a ready market, and an increasing demand for all the furs they could procure. They employed the Indians, who knew the habits of these animals, as hunters and trappers generally, paying for the skins taken by them

with some insignificant articles, always including the demoralizing fire-water, of which the aborigines seemed to be unnaturally fond. The French readily apprehended the character and wants of the natives, and engaged themselves in exploring the country, joining the Indians in the hunting and trapping of animals. The versatility of the French character fitted them to visit with comparative safety the savage tribes, to gain their confidence, and guide and direct them, so as to secure for themselves the greatest pecuniary benefit. This course was, in some respects, necessary, as valuable furs soon began to be scarce in the immediate vicinity of the trading posts and settlements. The Indians, therefore, accompanied by some of the traders or their dependants, were stimulated to take a wider range in their hunting expeditions. In this way, the best trapping grounds were discovered, and distant tribes of Indians were induced to bring their furs to the white settlements. At the close of each hunting season the Indians descended the Ottawa in their canoes laden with peltry, the product of the chase, and formed a kind of encampment outside the city of Montreal, where they exchanged their furs for knives, hatchets, kettles, blankets, brilliant colored cloth, and other articles suited to their wants, including arms and ammunition. No money was employed in their transactions; but the French traders expected to clear at least two hundred per cent. on the goods which the Indians received. After they had disposed of their furs, the Indians broke up their encampment, launched their canoes, and returned up the Ottawa to the lakes in search of more game.

A peculiarity of the fur trade about this time consisted in the appearance of certain French settlers, called "wood-rangers" (*Coureurs des Bois*). They left Montreal at the proper season in canoes laden with such articles of merchandise as were in demand among the Indians, and proceeded up the river to the hunting-grounds. They remained there an indefinite time, often more than a year, trading with the native trappers till their goods were all exchanged, when they returned, their canoes loaded with beaver skins and other valuable peltries. Some of these *wood-rangers*, while engaged in these protracted expeditions, conformed to the modes of life of the tribe with whom they were associated, adopting their dress, and not unfrequently taking to themselves Indian wives. The *wood-rangers* who carried on this trade were without capital, their investments of European goods being furnished by the merchants of Montreal. The return cargo was generally more

valuable than the investments, in the proportion of six to one. If the investment amounted to one thousand dollars, and the furs returned sold for six thousand, the merchant first repaid himself the original outlay, and secured an equal amount for interest and commissions, after which the remaining four thousand were equally divided between himself and the *Coureur des Bois*.

To carry on and protect the fur trade, it became necessary to establish forts at various places in the Indian territory, at the confluence of rivers, and on the lakes. The most important of these was established at Mackinaw, which became the place of deposit for goods and furs, the place of rendezvous for the wood-rangers, and soon took the place, in some respects, of Montreal itself. From this establishment new expeditions were fitted out for the Mississippi, Lake Superior, and the North-west; and from that point, also, furs were embarked for Montreal.

The French trappers and traders very soon found troublesome competitors in English traders established in New York. The importance of this trade attracted the attention also of rich and influential persons connected with the government of Great Britain, so that a still more formidable competition appeared in an organization called the Hudson Bay Company. A charter of incorporation was procured from Charles II. in 1670, granting the exclusive privilege of trading with the Indians in the vast and not well defined region lying north and west of the great inlet, from which the company took its name. The territory they claimed extended from Hudson's Bay west to the Pacific Ocean, and north to the Arctic Ocean, excepting only those parts occupied by French and Russians. The association founded several establishments, and carried on their operations with great vigor and success, often dividing among the stockholders dividends of fifty per cent. The affairs of the company were under the direction of a governor, deputy-governor, and a committee of management chosen from the stockholders resident in London. They established their forts and trading posts far into the interior of British America, and asserted an absolute power in the country, and over the Indians employed by them in hunting and trapping, although the charter of this company was not confirmed by act of Parliament.

In the year 1762 the French, by the fortunes of war, lost possession of Canada, and the fur trade came under the control of British subjects. Without the aid, however, of the French *wood-rangers*, who did not readily adapt themselves to their British employers,

the trade was greatly diminished. It was not until the year 1766 that the trade regained its former channels; but it was then pursued with much avidity and emulation by Canadian merchants, and soon exceeded its former bounds. By reason of rivalship and jealousies the trade was injured; the old French rule which had forbidden the sale of "fire-water" to the Indians was disregarded, in consequence of which scenes of drunkenness, brawls, and brutality were of frequent occurrence in the Indian villages and at the trading posts.

These sordid and ruinous contentions among individual merchants and traders were in part prevented by the principal merchants of Montreal, who formed a copartnership, in the year 1783, under the name of the North-west Company. This company was composed of twenty-three shareholders, comprising some of the most wealthy and influential British settlers in Canada, and employed about two thousand persons as clerks, guides, interpreters, and boatmen, who were distributed over all parts of the country. This famous North-west Company held for a time a lordly sway over the vast lakes, and forests, and rivers of the Canadas. Such of the shareholders as took an active part were called agents, some of whom resided at the different posts established by the company in the Indian territory, and others at Quebec and Montreal, where each attended to the business of the association. The young men who were employed as clerks were, for the most part, the younger members of respectable families in Scotland, who were willing to brave the hardships, and privations, and dangers incident to a residence for many years in these inhospitable regions. The inducements offered them were the advantages of succeeding to a share in the profits of the company, and if they had acquired the experience necessary for the management of the business, of becoming partners, as others died, or retired from the association.

The active partners of the company met once a year at Fort William, one of their stations near the Grand Portage, on Lake Superior, to discuss the affairs of the association, and agree upon plans for the future. The partners from Montreal went forth to these annual councils in great state. They were wrapped in rich furs, their huge canoes loaded with every convenience and luxury. They took with them cooks and bakers, delicacies of every kind, and abundance of choice wines for the banquets which were given at the great convocation. At the great feast, the tables groaned

under the weight of game of all kinds: venison from the forest, fish from the lake, with hunters' delicacies, such as buffaloes' tongues and beavers' tails. There was an abundance of wine, for it was in the days of hard drinking, loyal toasts, and bacchanalian songs. While the chiefs revelled in the banqueting chamber, there were noisy responses without from the mixed multitude of retainers, boatmen, half-breeds, and Indian trappers, who had their characteristic feasts, and revels, and songs, and dances.

It was perhaps natural that much rivalry and hostility should arise between the agents of the Hudson's Bay and North-west Companies. On this account the operations of both parties were impeded, and their prosperity interrupted. This opposition continued till the year 1821, when a union of the two companies was formed, and the trade since has been peacefully and successfully prosecuted under the name of the Hudson's Bay Company.

The early settlement of some of the western territories of the United States is due in part to the commercial interest awakened by the fur trade. As early as the year 1763 a French company was formed at New Orleans, which, under the guidance of M. Laclède, the principal director, established a trading centre at a place now occupied by the city of St. Louis. The brothers Chouteau were connected with this party, and remaining in the country, their name has been associated with the history of the fur trade and with that part of the country, then a wilderness, but now one of the most important portions of the United States. The enterprise of this company led them to explore the numerous tributaries of the Mississippi and the Missouri; and passing the Rocky Mountains, they established themselves on Lewis and Columbia Rivers. Several other companies were organized at different periods, in which appear the names of Major A. Henry, General W. H. Ashley, B. Pratte, J. J. Astor, Pierre Chouteau, and Cabanné, making St. Louis their centre of business. The average annual value of furs brought to St. Louis during a period of more than sixty years previous to 1845, was estimated at about two hundred thousand dollars.

The name of John Jacob Astor is perhaps the most conspicuous of the eastern merchants who have been engaged in the fur trade. Born in the village of Waldorf, near Heidelberg, on the Rhine, Astor, while a very young man, left his home for the busy scenes of London. At the close of the American revolution he was still in that great city, but was induced by an elder brother to seek his

fortunes in the United States. Before reaching New York he became acquainted with a countryman of his, a furrier by trade, from whom he learned the quality and value of different furs, and the mode of carrying on the traffic. In the year 1784 he made investments in furs, with which he sailed to London, and disposing of them to advantage, he returned the same year, and determined to settle in the United States. He entered at once into this branch of commerce, making annual visits to Montreal, where he purchased furs, and shipped them from Canada to London. As soon as the restrictions imposed on the trade with the colonies of Great Britain were removed, he opened a direct trade between Canada and the United States. From New York he shipped furs to different parts of Europe and to China. After years of profitable trade he endeavored to bring the fur trade within the limits of the United States into the hands of American citizens. To accomplish this, he obtained, in the year 1809, a charter from the Legislature of New York incorporating the "American Fur Company," with a capital of one million of dollars, with the privilege of increasing it to two millions. He furnished the capital, and constituted, in fact, the company. He succeeded in forming other companies; but his plans were seriously interrupted by the war with Great Britain in 1812. After the war the operations of Mr. Astor were limited to the territory this side of the Rocky Mountains.

Before the year 1848 the fur trade constituted the principal business interest of the territory of Minnesota. Later, St. Paul became a great rendezvous for traders and trappers, and the place from which furs are shipped to New York. The value of furs sent from St. Paul in the year 1857 was $182,491. The number of skins of all kinds sent to England from 1855 to 1858, from the Hudson's Bay Company and from the United States, amounted to 2,272,755. Among these were the skins of 1,168,250 muskrats, 440,196 raccoon skins, 11,805 skunk skins.

The choicest fur is that of the ermine, which is found almost exclusively in the cold regions of Russia, Sweden, and Norway. The stoat is said to be identical with the ermine, but has greatly inferior fur, and is found in North America. The fur of the ermine is of a pure whiteness throughout, with the exception of the tip of the tail, which is black. The fur of the ermine changes from a dingy brown to a pure white in the winter; the best fur is yielded by the oldest animals; their bodies are from ten to twelve

inches long. They are taken in snares and traps, and are sometimes shot, while running, with blunt arrows. The sable is a native of Northern Europe and Siberia; those of the darkest color are most esteemed; they are rated at from forty-five dollars to fifty dollars each; a cape of full size requires about sixteen skins. The skin of the American sable, or marten, is less valuable, though many among them are rich and of a beautiful dark-brown color. The fur of the beaver had once a high value, but hats being now made of cheaper materials, the demand for beaver skins has declined. The sea otter is found in the North Pacific Ocean, on the coasts of Asia and America. Its fur is highly prized in Russia and in China; that of the young animal is of a beautiful brown color, but when older it becomes jet black. Many thousands of skins of the skunk are annually exported from this country; they are worth from fifty to seventy cents each. The common cat is bred in Holland for its fur; many of the skins are used in the United States, and are worth from ten to fifty cents each. Bears of various kinds and colors, many varieties of foxes, beavers, raccoons, badgers, minks, lynxes, muskrats, rabbits, and squirrels are found in North America. The hides of bisons or buffaloes, and various kinds of deer, form part of the fur trade of North America; and sometimes the skin of the white arctic fox and of the polar bear are found in the packs brought to the traders by the most northern tribes of Indians.

FIRE-WORKS.

THE INTRODUCTION OF FIRE-WORKS IN EUROPE. — THE EARLIER KNOWLEDGE OF THE CHINESE. — THEIR LOVE OF FIRE-WORKS. — DESCRIPTIONS OF THEIR DISPLAYS. — FIRE-WORKS IN EUROPE. — THE MATERIALS USED IN THEIR PREPARATION. — THEIR USE FOR OTHER PURPOSES THAN SIMPLY DISPLAY. — DR. JOHNSON UPON THIS MATTER. — THE CONTRIBUTION OF CHINA TO CHRISTIANITY.

THE knowledge of fire-works in Europe cannot be historically traced to a great antiquity. They are an invention of comparatively modern times, and may be said to have been unknown in Europe until the discovery and use of gunpowder and cannon. But the Chinese, from a much earlier period, having some knowledge of the properties of saltpetre and sulphur, seem to have acquired great skill in the preparation and exhibition of fire-works. The English, in their early intercourse with the Chinese, attempted to surprise and interest them by a display of fire-works from one of their ships. But the attempt only excited the derision and ridicule of the Celestials, who, in their turn, soon showed their superiority to the English in the most astounding and amusing exhibitions of the art. Travellers in China have given accounts of the great variety and brilliancy of the fire-works in that country, which appear to greatly surpass those of all other nations. "One piece of remarkable interest was a box suspended at an elevation of some sixty feet, from which descended lanterns which gradually unfolded themselves to the number of five hundred, each one having a light of beautifully colored flame burning within it. From other boxes at the sides descended at the same time an immense network of fire, divided into regular figures of the greatest diversity of form and colors, flashing in great splendor, and constantly changing. The whole concluded with a volcano, or general explosion and discharge of suns and stars, squibs, crackers, rockets,

and grenadoes, which involved the garden for above an hour in an intolerable smoke."

Travellers in China are often treated to a serenade of bad music, and a very brilliant display of fire-works. Of the latter, a recent traveller says, "These were comprised, first of a prodigious quantity of crackers, suspended in large bunches on bamboo poles, their dry and noisy detonations never ceasing for a single moment. This perpetual cracking noise was only interrupted by the explosion of a sort of bombshell that went off very suddenly, and with a great noise; but the grandest pieces were placed at the angles of the court, where dragons and other fabulous beasts vomited fire at every pore. There were rockets of various colors, that shot into the air with splendid effect, and also a kind of wheel called by the Chinese 'a flying sun,' which pleased us most of all. It has merely to be put on a large plate, and placed on the ground; the wheel is then kindled, and immediately it begins to turn rapidly, throwing out bluish flames in all directions, and then suddenly springing into the air, it rushes to an immense height, and lets fall a fiery rain of all sorts of brilliant and varied colors."

The Chinese have always been passionately fond of powder, of which they knew the use long before the Europeans, but their taste is less decided for the kind made use of in war than for the milder sort employed for fire-works. They were fire-work makers before they were artillerists, and they have remained faithful to their first inclinations, liking squibs and crackers a great deal better than cannon. In all their festivals and solemnities of whatever character, — births, marriages, funerals, meetings of friends, theatrical representations, receptions of mandarins and great men, — they are sure to manage somehow or other to bring in fire-works. In the towns and villages you hear them popping and cracking at almost every hour of the night and day, so that one might take the whole Chinese empire for one great pyrotechnic establishment.

Among Europeans, the Italians appear to have been the first to acquire skill in the manufacture of fire-works, and at the present time they probably excel all other European nations in the pyrotechnic art. The Florentines and the Siennese were the first to prepare gunpowder with other ingredients for public amusements. They also invented machines and decorations adapted to increase the pleasure of the spectacle. They began their exhibitions at the feast of St. John the Baptist and the Assumption, on wooden edifices, which they adorned with painted statues, from whose mouths

and eyes issued a beautiful fire. Specimens of these pageants, under a great variety of grotesque forms, have been engraved, representing dragons, swans, eagles, etc., which were built up large enough to carry many persons, while they vomited forth the most amusing fire-works. The Florentines continue to the present day to introduce the festival of St. John the Baptist, the ancient protector of Florence, by illuminations, and an exhibition of fire-works on the Ponte alla Carraja.

The use of fire-works soon became popular at Rome; and when popes were elected they had illuminations and pyrotechnic displays from the Castle of St. Angelo. These exhibitions are still continued on various festivals, though they are shown from Monte Pincio, instead of the castle. The celebrated Girandola is among the grandest exhibition of fire-works in the world, embracing the discharge of four thousand five hundred rockets at one and the same time. Architectural forms of great beauty, outlined with various colored fire, with figures and names, are common in Italian exhibitions of this art.

An account of decorative fire-works is given in the *Secret Memoirs of France*. The exhibition was given by an Italian artist named Torre. The Parisians admired the variety and brilliancy of the colors and the ingenious forms of his fire. But the first exhibition was disturbed by the populace from some apprehension of danger. The exhibition was repeated in such a way that the beauty of the fire might be admired without fearing it. The display was closed with a transparent triumphal arch, and a curtain illuminated by the same fire, admirably exhibiting the palace of Pluto. Around the columns verses were inscribed, among which appeared the following, announcing a more perfect exhibition: —

"The icy gale, the falling snow,
  Extinction to these fires shall bring;
But, like the flowers, with brighter glow,
  They shall renew their charms in spring."

According to this promise of the artist, the exhibition was greatly improved. His subject was a representation of the forges of Vulcan under Mount Etna. The interior of the mount discovered Vulcan and his Cyclops. Venus was seen to descend and demand of her consort armor for Æneas. Opposite to this was seen the palace of Vulcan, which presented a deep and brilliant perspective. The labors of the Cyclops produced numberless

very happy combinations of artificial fires. The public with pleasing astonishment beheld the effects of the volcano, so admirably adapted to the nature of these fires. At another entertainment, the same artist gratified the public with a representation of Orpheus and Eurydice in hell; many striking circumstances occasioned a marvellous illusion.

Besides the amusement afforded by fire-works, they are, in one form at least, very useful. The sky-rocket is often used as a signal at night, as a projectile in time of war, and as a means of carrying a line to accessible objects, as to a wreck from the shore. The idea of using rockets in war was suggested by a Frenchman, — Hauzelet, — in the year 1598; but little or no progress was made in using this weapon until the experiments of Sir William Congreve, in the early part of this century, illustrated its importance. These rockets were first used with great effect by the British in the siege of Copenhagen in 1807. At the battle of Leipsic, a mass of French infantry were instantly routed by a volley of "Congreve rockets." Some thousands of them were made at the arsenal at Washington for use in the Mexican war. They have been very useful as a means of saving life. When a heavy surf prevents the life-boat from reaching a stranded vessel, a line attached to a rocket may be sent over the ship, by which those on board may be rescued. Lines have been carried from six to eight hundred yards by this means. The rockets for military use are made with strong iron cases, terminating at the head with a cone, and the rod, instead of being at the side, is so attached that its axis shall coincide in direction with that of the rocket. They are made of three, six, twelve, and even thirty-two pounds weight. They are generally fired from tubes, in order that the direction of their flight may be more certain; the proper elevation, at least for the smaller rockets, is about one degree for each hundred yards in the required range.

There are three prime materials used in making fire-works — saltpetre, sulphur, and charcoal, combined with filings of iron, steel, copper, zinc, rosin, camphor, etc. Gunpowder is used either in grain, half crushed, or finely ground, for different purposes. The longer the iron filings, the brighter red and white spots they give, those being preferred which are made with a coarse file, and quite free from rust. Steel filings and cast-iron borings contain carbon, and afford a more brilliant fire, with wavy radiations. Copper filings give a greenish tint to flame; those of zinc, a fine

blue color; the sulphuret of antimony gives a less greenish blue than zinc, but with much smoke; amber affords a yellow fire, as well as rosin and common salt; but the last must be very dry. Lampblack produces a very red color with gunpowder, and a pink one with nitre in excess; it serves for making golden showers. Camphor yields a very white flame and aromatic fumes, which mask the bad smell of other substances. Lycopodium burns with a rose color, and a magnificent flame; but it is principally employed in theatres to represent lightning, or to charge the torch of a fury.

The process of making fire-works should be conducted with great carefulness, in order to prevent explosions; the ingredients sometimes ignite spontaneously by being kept too long.

In the year 1749 it was proposed to celebrate, in London, the peace of Aix-la-Chapelle by an exhibition of fire-works. The proposal called forth an earnest letter of remonstrance from Dr. Samuel Johnson. He urged that debtors, widows, and orphans, the results of the war, might be relieved by the expense which was about to evaporate in smoke, and to be scattered in rockets. Instead of erecting some monument worthy not only of wealth, and power, and greatness, but of learning, wisdom, and virtue, the most costly preparations were made with no other design than a crowd, a blaze, and a shout; the mighty work of artifice and contrivance was to be set on fire for no other purpose than to show how idle pyrotechnical virtuosos had been busy.

However just and reasonable such protests may be against the waste of money and time in the preparation and display of fire-works, they were as little heeded a hundred years ago as they would be now. The "Heathen Chinee" has given certain kinds of light to Christian nations not soon or easily to be extinguished.

CARD CLOTHING.

EXPLANATION OF THE TERM. — CARDING AMONG THE ANCIENTS. — CARD-MAKING BY MACHINERY. — THE EARLIEST KNOWN ATTEMPTS. — THE BUSINESS DURING THE LAST CENTURY. — DURING THIS CENTURY. — THE USE OF DOG POWER. — THE CONDITION OF THIS INDUSTRY FORTY YEARS AGO. — THE SARGENT CARD CLOTHING COMPANY. — DESCRIPTION OF THE ACTION OF THEIR MACHINES. — THE ACCURACY OF THEIR MOVEMENTS. — THE DAILY PRODUCT OF A MACHINE. — THE EXTENT OF THE PRODUCTION IN THE UNITED STATES. — THE CAUSES OF THE SUCCESS OF THE SARGENT CARD CLOTHING COMPANY.

THE term "card clothing" is used by manufacturers to designate the "cards," or species of comb, used in the manufacture of cotton and woollen cloths for the purpose of carding out the fibres and arranging them in even and parallel lines, preparatory to spinning them into threads. From the very earliest times some appliance must have been used for the purpose of transforming the tangled masses of wool or cotton, which were destined to be spun, into an even texture, which could be used for this purpose.

Among the ancients, most probably, a utensil resembling a comb was used, and the wool or cotton was combed out. In modern times, even when all the spinning was done by hand, the cards were made of bits of wire, fitted into a strip of leather, or of wood. These were the hand-cards which those of us who are old enough to remember the time when spinning was the regular occupation of the women in every family, must have frequently seen in use.

With the introduction of spinning by machinery, the process of carding has come to be carried on in the same way, and "card clothing" is the cards made in strips long enough to cover the large cylinders in which this operation is now performed in our manufactories.

The making of cards by machinery is also one of the novelties of the modern era of industry, and the machine with which this

difficult and delicate process is performed is also an American contribution to the mechanical progress of civilization.

During the colonial period of the history of the United States, the manufacture of hand-cards, by the process of hand labor, was an important branch of the industry of the country. This method of manufacture continued in use until this century, though various attempts had been made to substitute machine labor for it.

In 1775 Nathaniel Niles, of Norwich, Conn., set up in that place a manufactory for making the wire to be used in making cards; and the Assembly, in view of the importance of the project for the manufacture of cotton and woollen cloth, granted him, in answer to a memorial addressed to this body by Mr. Niles, a loan of three hundred pounds for four years. This manufactory was continued in operation during the war of the Revolution.

Following the example thus set, several other of the legislatures in the colonies recommended the manufacture of cards, with other appliances for the production of textile fabrics, and encouraged them by bounties or loans.

In 1777 Oliver Evans, one of the most distinguished pioneers in the army of American inventors, being then a young man of about twenty-two, having been engaged in manufacturing the teeth for cards by the hand process then in use, invented a machine for manufacturing them, which is said to have been efficient, and to have produced them at the rate of three hundred a minute.

He made proposals to the state for aid in establishing a factory for drawing the wire and making it into card-teeth by the machine, in less time than it took to coil the wire into hanks. His proposals not having been accepted, he sold his invention to private parties; but it does not appear that it was put into practical operation.

It is also stated that he subsequently invented another machine, which would prick the leather, and cut, bend, and set the teeth, but which he abandoned for personal reasons.

In Massachusetts, in 1788, Giles Richards & Co. began in Boston the manufacture of cards with machinery, which, it has been suggested, was that invented by Evans. In 1793 there were three manufactories of cards in Boston, with an annual production of twelve thousand dozen cards, all of which were, of course, hand-cards. Nor were these the only manufactories in Boston, or in the state.

In 1784 a machine was invented by Mr. Crittenden, of New Haven, Conn., which cut and bent the teeth, and was capable of producing eighty-six thousand in an hour.

In 1796 Amos Whittemore took out a patent for an improvement in making cards.

During the early part of this century the making of cards increased, and became an important branch of industry in the country. Machines were used quite generally, and were frequently run by dog power. New England was the chief seat of the manufacture, and Mr. Joseph D. Sargent, of Leicester, was one of the largest producers of cards in the country.

He at first used dog power for cutting the teeth by machinery. A dog was able to run about six machines, each of which would cut about twelve pounds of teeth in a day, from No. 32 wire, or wire of medium size. The daily product of each machine was enough to cover about twelve square feet of leather, or "fillet," as it was technically called.

These teeth were put up in bags, and distributed to the residents of the vicinity, who stuck them into the leather, and returned the cards. All through Worcester County, Mass., card-making was a recognized business, and frequently a factory sent out its work within a radius of twenty miles. Men, women, and children engaged in it, and some of them made it their sole occupation. The pay for the work averaged from twenty-five to forty cents, according to the fineness of the teeth, for a "sheet," which averaged five inches in width by thirty-six inches in length. For setting the teeth in a "fillet," forty feet long by an inch and a half wide, with which to cover the small cylinders on a carding machine, the price in those days was two dollars and a half. Women and girls were found to be the most expert workers, and were very generally engaged in this work when there was a factory in the vicinity. Foreign labor was then almost unknown in the United States, and the ancestors of many of the richest and most influential families of the present day were, as girls, engaged in the work of card-making.

Machines for forming the teeth were then in use, and though most of the wire used was imported, yet wire was then made in the country, a factory at Leicester, Mass., being driven by a windmill. In 1812 the largest card factory at Leicester, Mass., employed about eighteen hands in the cutting of teeth, two thirds of whom were girls employed in turning the machines.

Until within about twenty years this town was the principal seat of the card manufactory in the United States, and is to-day one of the richest towns of its size, as the result of its devotion to this industry.

The leading representative house engaged in the manufacture of card clothing is the "Sargent Card Clothing Company," of Worcester, Mass. The business has partaken of the great industrial activity of the present century, and is now one of the most important industries of the country. This company was formed by its president, Mr. Edward Sargent, the son of the late Joseph D. Sargent, of Leicester, who was in the business of manufacturing cards as early as 1812; and under his management the company holds the first rank among the firms engaged in this branch of business, producing daily about seven hundred square feet of card clothing, besides about two hundred dozen pairs of hand-cards.

WORKS OF THE SARGENT CARD CLOTHING COMPANY, WORCESTER, MASS.

The operations are all carried on by machines, which are an improved arrangement upon a machine invented by a Mr. Smith, who is said to have realized but little from its invention. It is a combination of a "drawer," a "cutter," "doubler," "pricker," "second bend," "dogs," and "feed-wheel," as the principal parts. The wire is placed upon a reel beside the machine, and one end of it being placed by hand in the "drawer," all the other processes of the work are done automatically by the machine.

The leather in which the teeth are to be set is "fed up" from beneath the machine, and drawn gradually along, as the teeth are set, over a pulley set in the ceiling above.

The "drawer" pulls along enough of the wire to make a tooth, and places it in front of the "doubler," where it is cut off by the "cutter," and seized in the middle by the doubler, and bent into the shape of a card-tooth, ready to be inserted in the leather. At the same moment the tooth is driven into the holes in the leather, which the "pricker" has made just before for the reception of the two prongs of the tooth. Then the "plate," a portion of the "doubler," sticks the tooth nearly its full length into the leather, when the shoulder of the pricker, as the latter makes the holes for the next tooth, finishes sticking the tooth in and fastening it.

These machines are so accurate in their movements, that, should the wire give out or prove defective, or any of the operations be imperfectly performed, the fact is discovered by another portion of the machine, which keeps a constant and vigilant scrutiny over the work, and by a "stop motion," as it is called, stops the working of the machine. This portion of the machine is, however, more frequently called into action by imperfections or kinks in the wire than by a failure in any of the automatic motions.

One of these machines will set about four square feet of teeth in ten hours, there being about thirty-three thousand teeth, or, as technically described, sixty-six thousand points to a square foot, making about two hundred and sixty-four thousand points set in a day.

The Sargent Card Clothing Company's Works are spacious and handsomely built. They are situated at the side of the railroad, so as to forward their goods economically. In the United States there are about twelve hundred card clothing machines in operation, producing daily about thirty-six hundred square feet of "clothing," of which the Sargent Card Clothing Company produces about one fifth, or seven hundred feet a day, besides the hand-cards they also make. The successful organization of this leading business in this specialty is due chiefly to the ability with which it has been managed by Mr. Sargent, who devotes his entire time to it, and to the high reputation the company has always enjoyed for the probity of their dealings and the excellence of their products, it having been an invariable rule from the beginning that no goods of theirs should leave the establishment unless they were perfect of their kind.

CALLIOPES.

A DESCRIPTION OF THE CALLIOPE. — ITS FIRST INTRODUCTION. — ITS INSPIRATION OF THE MUSE. — A DESCRIPTION OF ITS MUSIC. — A SUGGESTION FOR ITS PROPER USE.

THE Calliope is an invention by which steam whistles are made to discourse very loud, if not sweet music. It is a simple but ingenious machine, consisting of a steam cylinder, along the top of which valve chambers are arranged, having double, steam-tight, metallic valves. By means of a stem or rod passing from each of the valves through the steam chamber, they may be opened by a slight pressure; when the pressure ceases, the valves instantly close. A steam whistle, having its own peculiar tone, is placed over each valve. The instrument is double in its construction, and can be played by striking keys similar to those of an organ; or, by means of a cog wheel, may be set to a particular tune, like a common music-box. Its musical strains, in well-expressed tunes, may be heard five miles on land, and much farther on water.

When the Calliope was first introduced to the public by the inventor, Mr. I. C. Stoddard, the people of Worcester, Mass., were greatly surprised by strains of music, very loud, very clear, and very singular. The programme of that memorable evening concert consisted, in part, of the "Marseilles Hymn," "Life on the Ocean Wave," "Sweet Home," "Susannah, don't you cry," "Old Hundred," "Old Dog Tray," and "Flow gently, sweet Afton." All the city heard the music, and at the distance of five miles the air was full of the melody. Everybody wondered what band it was, or what instrument had waked up; and one old lady thought the Angel Gabriel had come with the last trump.

The appearance of one of the Muses, under the inspiration of *steam*, secured a poetical record, in which Calliope is thus represented: —

"O'er fields and seas she takes her airy flight,
Until on fair Columbia's soil they light;
Here to achieve, by nobler deeds sublime,
What had been lost in the Ægean clime.
And first, the railroad horse's lungs she stole,
And next, by wood or Pennsylvania coal,
Expands her giant voice, so loud, so great,
It shook all round, throughout the Old Bay State.
Such music tall was never heard before,
No, not in Greece or Rome, in days of yore."

The music is represented as indescribably droll — the comicality of melody. A dozen or two of the steam whistles of ordinary locomotives, with their screaming element materially softened; a hand organ or two, without their usual *grating* sensation, which sets the teeth on edge; a few flutes, through which every note is clearly and distinctly *tongued,* and a *very* slight piano accompaniment, all acting in perfect accord as to time, give a good idea, expressed in words, of the wonderful Calliope. The music is supposed to be good for the dyspepsia, has an excellent influence on torpid livers, and cures melancholy in a moment; in short, it is *the* music for invalids.

If this instrument should be generally adopted where steam whistles are now used, which, like the hinges of Milton's "infernal doors," "grate harsh thunder," a great nuisance would be replaced by this comical, but not altogether disagreeable, Steam Piano.

SHOT.

THE PROCESS OF MANUFACTURE. — THE TRADITIONAL ACCOUNT OF ITS FIRST SUGGESTION. — THE VARIOUS SIZES OF SHOT. — HOW THEY ARE ASSORTED. — WEIGHING BY GRAVITY. — THE FIRST SHOT-TOWER IN THE UNITED STATES. — THE NEW METHOD PROPOSED FOR THE MANUFACTURE OF SHOT.

Shot are generally made of lead, with which arsenic has been mixed, although sometimes lead of an inferior quality is used simply for this manufacture. The effect of the arsenic is to render the lead softer and more ductile, instead of hard and brittle, so that when melted and subjected to the usual process in shot-making, it will more readily take the globular form. The softer the lead, the less arsenic is required; but hard lead requires arsenic in the proportion of ten parts in one thousand. When the lead is properly combined with the arsenic, which is determined by trial, it is formed into bars, and raised to the top of a tower, erected for the purpose, to be melted again, and transformed into shot.

The usual method of shot-making has some resemblance to the process by which rain is transformed into hail. The liquid lead is made to fall from a high elevation; in passing through the air this leaden rain becomes cool, and hardens into leaden hail or shot. The common method of shot-making is said to have originated with a plumber of Bristol, named Watts. About the year 1782, he dreamed that he was exposed to a shower of rain, that the clouds rained lead instead of water, and that the drops of lead were perfectly round. Inspired by this dream, he determined to try the experiment. He accordingly ascended the tower of a church, and poured some melted lead into some water below; the plan was successful, and he sold his invention for a large sum of money.

In carrying out the idea suggested by this dream, if such was its real origin, shot-towers have been constructed, varying in

height from one hundred to two hundred and fifty feet, according to the size of the shot to be made, the larger size requiring the greater height. The lead is melted at the top of the tower, and poured into a colander, and the drops are received in a vessel of water at the bottom. The surface of the lead, when melted, is covered with a spongy crust of oxide, called *cream*, which is used to coat over the bottom of the colander, in order to prevent the lead from passing too rapidly through the holes, and to perfect the roundness of the shot. The colanders are made of sheet iron, the holes differing according to the size of the shot, though the shot are always larger than the holes through which the melted lead passes. The lead passes through the colander in fine threads, which collect in globules of the size of the shot on the under surface of the colander. In falling to the bottom of the tower, the entire surface of the shot is equally acted on by a current of air. By this means they take their proper form, and are sufficiently cooled, though still soft, to bear the shock of falling into water, without flattening or changing their shape. The holes in the colander for shot, known as No. 0, are one fiftieth of an inch in diameter; for No. 1 the holes are one fifty-eighth of an inch; and from No. 5 to No. 9 the diameter decreases by regular gradations, the latter being only one three hundred and sixtieth of an inch. When the shot are removed from the water, which is sometimes done by an endless chain of boxes, they are thoroughly dried by steam on iron plates, or in iron boxes. The imperfect shot are then separated from those which are well formed by causing them to pass over a number of inclined planes, arranged one above another. The perfect shot proceed rapidly in a straight line, and fall into boxes placed to receive them a few inches from the edge of the inclined plane. The ill-shapen pieces of lead — oblong, or partly round — move in zigzag, and more slowly, and fall into boxes placed immediately at the edge of the plane. If the first boxes do not receive all the imperfect pieces, they are likely to disappear in the boxes below the second inclined plane; so that at the bottom of the slope only the perfect ones fall into the trough placed to receive them. The good shot thus separated from the bad are of a dead, silvery-white color. They are then placed in the polishing barrel, containing a small quantity of pulverized plumbago, where, after many revolutions, they receive their superficial finish. They are then assorted according to their sizes by sifting them from boxes, the bottoms of which have holes

corresponding to the different sizes of shot, or by sifting them through a revolving copper cylinder placed on an incline, having holes which increase in size towards the lower end. Thus the smaller drop through first, and the larger lower down, each size being received in its own box. Being thus assorted, they fall into boxes, each of which has a tube and a faucet, so arranged that the bag placed over the mouth of the opened tube receives precisely twenty-five pounds of shot, when it instantly closes, obviating in this way the necessity of weighing each bag of shot.

In the year 1807 the patent shot-tower of Paul Beck was erected on the Schuylkill. It was on a large scale, being one hundred and seventy feet high, and very complete in its machinery. It was supposed to be capable of supplying the entire demand for shot in the United States. Many other shot-towers have been built since that date. A mode of manufacturing shot without the high towers has recently been patented, substituting in their place a low elevation, up which a powerful current of air is made to pass, thus producing the effect of a long-continued fall.

GLOVES.

DESCRIPTION OF THE WORD GLOVE. — THE ANTIQUITY OF THEIR USE. — ANCIENT CUSTOMS CONNECTED WITH WEARING GLOVES. — THROWING DOWN THE GLOVE AS A CHALLENGE. — THE CHIVALRIC USES OF THE GLOVE. — THE GLOVE IN POETRY AND ROMANCE. — QUEEN ELIZABETH'S GLOVES. — GLOVES IN MODERN TIMES. — THE PROCESS OF MANUFACTURE. — MATERIALS FOR GLOVES. — THE DECREE OF FASHION.

Glove, in the Anglo-Saxon *glof*, signifies a covering for the hand. It has a separate cover for each finger, and is used both as a protection for the hand and as an article of dress. Doubtless some form of the glove, as a hand-covering, has been in use among different peoples from a very early period. It was a very ancient custom to conclude a contract by giving as a pledge a glove. When Boaz purchased the field of Ruth the Moabitess, there existed a similar custom of confirming the contract. In earliest times, among the Hebrews, estates were exchanged or bought, not by written agreements, but by signs or ceremonies. "To confirm all things, a man plucked off his shoe, and gave it to his neighbor" (*Ruth* iv. 7), as in later times a house was transferred by giving the key, and land by giving turf and a twig. In transferring the possession of Ruth to Boaz, the ceremony used was, "he drew off his shoe;" but the Chaldee paraphrase reads, "the glove of the right hand." This would seem to be a more agreeable and reasonable ceremony than that of plucking off the shoe. It is conjectured that gloves were worn by the Chaldeans, from the word here mentioned being explained, in the *Talmud* Lexicon, "the clothing of the hand."

The rude Tartars used a covering for the hands something like gloves, not separated into fingers. The Persians are charged in history with effeminacy, because, not satisfied with covering their heads and their feet, they protected their hands from cold by wear-

ing thick gloves. The secretary who accompanied Pliny in his journey to Vesuvius had gloves on his hands, that the coldness of the weather might not prevent him from recording whatever occurred remarkable. The records of ancient manners and customs speak of using gloves to protect the hands from thorns; of olives gathered by the naked hand as better than those gathered with gloves; also of a celebrated glutton, who always came to the table with gloves on his hands, that he might handle and eat the meat while hot, and so devour more than the rest of the company. As early as the first century of the Christian era, the wearing of gloves by the Romans was regarded as a departure from the ordinary habits of the people. "It is shameful," said a philosopher of that age, "that persons in perfect health should clothe their hands and feet with soft and hairy coverings." But it may be supposed that their convenience and utility soon induced their general use.

In the middle ages, kings, nobles, and dignitaries of the church used most costly gloves as articles of dress; they were sometimes richly adorned with precious stones; though a council, in the reign of Louis le Debonnaire, ordered that monks should only wear gloves made of sheep-skin. Bishops were sometimes put in possession of their sees by receiving a glove. A similar gift often accompanied the ceremony of *investiture* and the *conferring of dignities.* They were at one time regarded as a peculiarity of the dress of bishops; and in some parts of France other lower orders of the clergy were forbidden to wear them. As dignities and offices were conferred by the giving of gloves, so they were taken away as a mark of degradation. It is related of the Earl of Carlisle, in the reign of Edward II., impeached and condemned to die as a traitor, that his spurs were cut off with a hatchet, and his *gloves* and shoes were taken off.

To throw the glove, by way of challenge to a duel, is mentioned as early as the year 1245. Throwing down the glove as a challenge, which the opposite party accepted by taking it up and throwing down his own, is spoken of as *mos Francorum* — a French custom. When Conradin lost his crown, and was about to suffer death on the scaffold, he threw his *glove* among the crowd, asking that it might be conveyed to some of his relatives, who would avenge his death. It was taken up by a knight, and carried to the King of Arragon, who, in virtue of this glove, was afterwards crowned at Palermo. At the coronation of English

sovereigns, the ceremony of challenging by a glove is still observed. When Henry IV. was crowned, a knight, "armed for wager of battle," entered the dining-hall, and, in the presence of the king, threw down his glove, as a challenge to any knight or gentleman who should dare maintain that King Henry was not a lawful sovereign. Later, the king's champion has been accustomed to make his challenge in Westminster Hall, which he entered armed and mounted, as was done when Victoria was crowned.

In the days of chivalry, the glove of a lady, worn in the helmet as a favor, was a very honorable token; and the faithful knight's success was supposed to come from the *virtue* of the lady; whence the desperate boast of Henry of Monmouth, —

> "His answer was, he would unto the stews,
> And from the commonest creature pluck a *glove*,
> And wear it as a favor; and with that
> He would unhorse the lustiest challenger."

Schiller, in his poem *The Glove*, describes the incidents attending a combat among wild beasts: —

> "Now, from the balcony above,
> A snowy hand let fall a glove;
> Midway between the beasts of prey,
> Lion and tiger, there it lay —
> A winsome lady's glove!
>
> Fair Cunigonde said, with a lip of scorn,
> To the Knight Delorges, 'If the love you have sworn
> Were as gallant and leal as you boast it to be,
> I might ask you to bring back that glove to me.'"

The knight accomplished the perilous service, and, amid loud expressions of joy and praise, he bore back the glove.

> "With a tender look in her softening eyes,
> That promised reward to his warmest sighs,
> Fair Cunigonde rose, her knight to grace;
> He tossed the glove in the lady's face!
> 'Nay, spare me the guerdon, at least,' quoth he;
> And he left forever that fair ladye."

A similar incident is the subject of poems by Leigh Hunt, and by Browning.

The Saxon origin of the word "glove" (*glof*) shows its very early use in England. Queen Elizabeth had a great partiality for perfumed gloves trimmed with roses of colored silk, especially for those presented to her by Edward Vere, when he came from Italy.

At the sale of the Earl of Arran's effects, in the year 1759, the gloves given by Henry VIII. to Sir Anthony Denny were sold for thirty-eight pounds seventeen shillings; those given by James I. to his son, Edward Denny, for twenty-two pounds four shillings; and the mittens given by Queen Elizabeth to Sir Edward Denny's lady, for twenty-six pounds four shillings. The expression *glove silver* is found in the old English records, signifying money given to servants to buy gloves. This is probably the origin of giving a pair of gloves for any favor or service. The custom of giving gloves and a scarf to the clergy and bearers at funerals is still observed in this and other countries.

Gloves are made of a variety of materials — silk, cotton, thread, linen, and woollen, and the skins of animals, with and without the fur. In France and Italy the manufacture of gloves has been carried on for centuries; and in these countries this industry has been brought to a great degree of perfection. In this product the English cannot compete with the French and Italians, though of the heavier varieties of leather they make large quantities of very superior gloves. In the process of making gloves, the skin is stretched on a marble slab; it is cut with a pair of scissors through the middle, dividing it into two equal parts; the single strip for the palm and back is cut from one end of the half skin; the other smaller pieces required are cut from the same skin, or from others precisely like it. By skilful management the French and Italian glove-makers will get one or two pairs more than an Englishman from the same skins. And this is a great gain, when it is considered that in France above four and a half millions of skins are cut up into gloves every year. Formerly, in making the hole for the thumb, great care and skill were required to secure a good fit; but later improvements secure the cutting of the thumb-piece, like the fingers, in the same piece, requiring no seam for its attachment. The cutting is also chiefly done by means of punches of suitable patterns, which are provided with an apparatus which pricks the places for the stitches, so that the seams can be sewed with great regularity and precision. When the gloves are sewed, they are stretched, wrapped in damp linen cloth, and beaten, so as to render them soft and pliable; they are then pressed, and are ready for market.

Leather gloves are made in England in Worcester, Woodstock, Yeovil, Ludlow, and London. In the town and neighborhood of Worcester six millions of pairs are made annually. The manufac-

ture of gloves is most extensively carried on in France, and the best French gloves are said to be made in Grenoble. Many gloves are made in Italy, Naples, Milan, and Turin being the principal places where they are manufactured. They are inferior in quality to French gloves, and are much cheaper, though in appearance there is not much difference. Great quantities of gloves in France and Italy, called *kid*, are really made of *rat*. Buckskin gloves are peculiarly American, and are largely manufactured in the State of New York.

As an article of dress, gloves are of great importance. In the month of July, 1871, the style of gloves is thus described: Palest primrose buff is the leading color in the new stock of gloves; and next in proportion is pale gray, with a lavender cast — a shade specially pretty with black toilets. Gloves fastened by but one button are seldom seen on well-dressed ladies. Long-wristed gloves, the wrist-piece cut in one with the glove, instead of being a separate band, are preferred. Those fastened by two or three buttons are most used in the daytime. From four to six buttons are on evening gloves. Those without fancy stitching on the back are in best taste.

Dr. O. W. Holmes has given his opinion about gloves, as he has of many other things out of the line of his profession.

> "Wear seemly gloves; not black, nor yet too light,
> And least of all the pair that once was white:
> Let the dead party, where you told your loves,
> Bury in peace its dead bouquets and gloves.
> Shave like the goat, if so your fancy bids,
> But be a parent — don't neglect your *kids*."

The Italians have a proverb, *Gatta guantata non piglia sorice*, which we translate, "Cats in gloves catch no mice," or, "A muffled cat is no good mouser." It is spoken of those who go about their work without first preparing for it, or removing those things which may impede their progress or endanger their success.

OIL CLOTH.

THE USE OF OIL CLOTH. — THE PROCESS OF ITS MANUFACTURE. — THE APPLICATION OF THE COLORS. — THE METHOD FOR TRANSFERRING THE PATTERNS. — THE BLOCKS USED IN THE MANUFACTURE. — THE EXTENT OF THE MANUFACTURE.

The custom of covering floors, halls, and passages is very general. Where warmth and comfort are desired, carpets are used. Where something more durable and less costly is demanded, a covering of oil or floor cloth has been invented. This cloth or canvas is a very strong fabric, made of flax and hemp, painted on both sides, the under side being plain, the upper side ornamented with patterns or designs of two or more colors. The cloth used for this purpose should be without seam; so that when pieces of great width are required, two men are employed at the loom, one on each side, for throwing the shuttle back and forth. This kind of cloth being woven for this purpose alone, its manufacture forms a distinct branch of business. Pieces are made from eighteen to twenty-four feet wide, and the length often exceeds one hundred yards.

When the canvas is received at the manufactory, the bales, containing one hundred or more yards, and weighing nearly six hundred pounds, are opened, and cut in pieces of sixty or one hundred feet, as may be required. These pieces are then taken to the "frame room," which consists of a number of strong wooden frames, standing upright, a few feet from each other. The space between the frames is occupied by a scaffold of four tiers, which may be reached by means of a ladder at one end of each frame. The edges and ends of the canvas are fastened to the frame, and by means of screws the beams of the frame are moved so as to tighten and stretch it to its utmost tension. In this position every part of the cloth can be reached from the several platforms. The

first operation, preparatory to painting, is covering the back of the canvas with a weak solution of size, applied with a brush; and while yet damp, the canvas is thoroughly rubbed with pumice-stone. By this means the irregularities of the surface are removed, and the size penetrates the interstices of the cloth, so preventing the paint, which is afterwards applied, from penetrating too far, which would render the oil cloth hard and brittle. This priming and scouring are carried on from the top downwards.

When the surface is dry, a coat of paint, made of linseed oil and some cheap coloring matter, is applied. This paint is very thick, and is thrown on to the canvas in dabs with a short brush; it is then spread with a long and very elastic steel trowel. The paint is thus thoroughly worked into the web of the cloth, filling up all inequalities, and rendering the surface smooth and level. This "trowel-color," as it is called, is allowed to dry ten days or longer, according to the weather, after which a second coat is smoothly laid on with the trowel, which completes the work for the under side of the canvas. After the first coat of paint is applied to the under side, the same process is commenced on the face side of the cloth; the size is applied, then rubbed in with pumice-stone; the first trowel-color is then put on, which, when dry, is also rubbed down with pumice-stone; two more coats are applied with the trowel, with a pumice-stone rubbing after each. Finally, a fourth coating of paint is applied with the brush, which is the ground color for the designs which are to be printed on it. The floor cloth is thus completed, the various operations occupying from two to three months, when it is ready to be removed from the frames and transferred to the printing rooms.

The printing of the cloth is done on a flat table, over which it is drawn as fast as the designs are impressed. This is done with wooden blocks, not unlike those used in the old method of calico printing. As the patterns generally consist of several colors, there are as many blocks and as many separate printings as there are colors in the designs. "In preparing a set of blocks for printing oil cloths, an accurate colored sketch of the design is first made on stout paper. A blank sheet of paper is then placed under this, and by means of a sharp point, all that portion of the device including one color is marked on the under sheet in a series of dots, or holes. This being removed, another blank sheet is placed under the pattern, and all the figures of another color are pricked out in a similar manner. Thus the pattern is dissected on

as many sheets of paper as there are colors to be printed. One of the pricked sheets is then fixed on the surface of a block, and a little powdered charcoal is dusted over it from a muslin bag, so as to penetrate the hole. The dotted line thus made on the block serves to guide the pencil of the engraver when the paper is removed, and enables him to draw the portion of the pattern required for that block. The same plan is pursued with other blocks, which are then ready for the engraver, who cuts away the wood, and leaves the pattern in relief."

The blocks used for printing are generally about eighteen inches square, the engraved portion being made of some close-grained wood, such as the pear tree, and fastened to blocks of pine. These engraved blocks, in large establishments, constitute a very valuable portion of the stock. Before the designs are impressed on the cloth, it is made slightly rough by means of a steel scraper and a scrubbing-brush, which prepare it to receive the colors more readily. Near the printing-table is placed a number of flat cushions, on which the coloring matter is first placed with a brush. The printer presses the block on the cushion, which is charged with the color, and then applies it to the cloth, holding it firmly, at the same time striking it several blows with the handle of a heavy hammer. A second printer charges his block with a different color, and applies it in the same manner. He is followed by a third, and as many others as may be required to form the most variously-colored pattern. As fast as the cloth is printed it passes through an opening in the floor to the drying room, where it becomes hard and ready for use. Narrow pieces, for halls and stairs, are first cut the required width, and printed in the same manner, except that a space is left on each side for a border, which, requiring smaller blocks, is put on afterwards. Sometimes drying oils are used to hasten the completion of the work; but this makes the cloth brittle, and of inferior quality.

There are various large manufactories of oil cloths in the United States, and the value of their production is about two millions and a half of dollars yearly. A still cheaper floor covering is made of stout, strong paper, painted in colors, but has not yet attained an extent which enables it to be called a "great industry."

THE ALDEN PROCESSES.

SCOPE OF THE ALDEN PROCESSES. — MR. ALDEN'S BIRTH AND BUSINESS CAREER. — INVENTS CONDENSED MILK. — BEGINS THE BUSINESS OF DESICCATING FRUIT AND VEGETABLES. — PERFECTS THE ALDEN PROCESSES. — ABSORBENT POWER OF AIR. — SUPERMATURATION, AN IMPROVEMENT ON NATURAL RIPENING. — INCREASED PROPORTION OF SUGAR FROM THE ALDEN PROCESS. — DETAILS OF MODE OF USING THE AIR-BLAST. — THE REMAINING WATER CHEMICALLY BOUND. — EFFECTS OF THE ALDEN PROCESS IN CONDENSING AND PRESERVING. — COST AND CAPACITY OF THE ALDEN EVAPORATOR.

If he were a benefactor beyond estimation who should make another blade of grass grow beside each blade of grass that grows, is he less who presents us with another fruit and another vegetable rescued from decay for every one (of the perishable kinds) which the methods hitherto in use have preserved from the bountiful largess of Nature? — who puts an end to a waste of food and a destruction of wealth that had run through half the sustenance of man, cutting it down by from one fourth to one half in every department of consequence except cereals, and probably inflicting more loss than all the ravages of fire, flood, and tempest on land and sea, with drought, mildew, and vermin to boot? *

To the incredulous reader, who may suspect some rhetorical exaggeration in the estimate of the Alden processes, above expressed, we hereby give warning that we shall tax his faith with a great deal more than that, and aggravate the offence by proving it. We shall also show that Mr. Alden's contribution to organic and applied chemistry is as far-reaching and as wide-reaching as we have represented his reformation of our modes of preserving the fruits of God's bounty to be. It will turn out that he has showed us how to increase and improve, directly and to a seemingly fabulous extent, the product of all vegetable and animal substances that require an

* An authentic statement in the New York Tribune, of August 23, 1871, informs us of the case of a single fruit-grower in Delaware, whose loss of peaches in that season by rot amounted to not less than ten thousand bushels, for want of a market; while the total loss in the same little State from the same cause is described by hundreds of thousands; all of which will be saved annually by a few Alden Evaporators at convenient locations.

elemental change in preparation or preservation for the food of man. The details in the development of the twofold subject will prove as beautiful and remarkable as the exordium is startling.

As these results are not accidental, but the ripe fruit of a life laboriously devoted to the subject, we can hardly go amiss if we first invite the reader to a personal introduction, and a review of the hidden rise and unobserved progress of the new art. We may take it for granted that he has heard of condensed milk; also of desiccated vegetables and meats; also, very likely, of prepared cream coffee, clarified cream cocoa, etc. All these are an old familiar tale. Permit us, then, to introduce in the first place the author of condensed milk and the other preparations named, besides many as yet unnamed here or elsewhere, — Charles Alden, of Newburgh. Mr. Alden has been a citizen of Newburgh (on the Hudson) the last twelve years, but, like a majority of inventors, he was born a Yankee. It was in Randolph, Massachusetts, the great (men's) shoe town, a few more miles south of Boston than Lynn, its feminine counterpart, is north of the same, that a son was born in the early part of the present century to Silas Alden, Jr., progenitor also of the large leather-working industry for which the place is now famous. The son was named Charles, and was early destined for college in the paternal mind. But having tasted to his satisfaction of the tree of knowledge at Phillips Academy at Andover, by the age of fifteen he manifested another vocation by going to sea, — a two years' voyage to Africa, as clerk and steward in the brig Minerva of New Bedford, Captain Gifford. This experience was undoubtedly, though unconsciously, a determining element in his after career. Doing with his might, as he always did, whatever his hands could find to do, he became so good a sailor that he had the opportunity to refuse the position of second mate for a second voyage, and settled down at home to the life of a live Yankee, inventing and manufacturing, marrying, assisting to carry on his father's business, and initiating a number of successful manufactures, one of which was that of palm-leaf hats, and another the single-seam over-shoe, which prospered until Goodyear's invention undid it.

But it is unnecessary to trace the enterprises and vicissitudes of Mr. Alden's busy life until we find him settled in New York, in 1842, as a wholesale shoe and leather dealer, subsequently in the City Council, and in 1850, having eagerly embarked in a succession of inventions with varied luck, at last out of business, and at the

very "nadir" of his fortunes. It was the most fortunate juncture of his life; perhaps we might say of any life in this century. His old stewardship at sea now bore its long-hidden fruit. A cup of coffee in a powder, with milk and sugar, clarified and ready (boiling water but granted) to drink at a moment's notice, was his idea. He went straight home with it, and brought the thing to pass before he slept. It eventually took the form of a paste, rather than a powder, however, and such was the birth of Condensed Milk. Mr. Alden immediately hired a secluded tenement for his laboratory, and pursued his experiments until he produced the preparations known as condensed milk and clarified cream coffee and cocoa, reduced by the evaporation of three fourths of the water, and put up in cans ready for sale, at a fair profit. With these he opened a traffic with shipping merchants, sea captains, travellers, and, to a limited extent, families. Nothing could have been more opportune than this new product for the immense picnic of gold-hunters just then begun on the Pacific coast, and depending for every necessary and comfort of life upon supplies shipped from New York around Cape Horn. A standing California contract, demanding a large daily production of condensed milk, was provided for by the erection of the first regular factory for the purpose in the vicinity of Poughkeepsie. At this establishment were condensed from three hundred to five hundred quarts daily. After this, improvements began to be made in the apparatus. The evaporating-pans were increased from a capacity of eight or ten gallons to two barrels. They were set in steam, and the steam-stirring fan was introduced, which consisted of two blades on a vertical shaft, revolving rapidly in the milk, and creating strong currents of air through the agitated liquid, for hastening evaporation while lowering the temperature. This involved the germ principle of the ultimate and universal evaporating process now under consideration. In 1857 patents were obtained for these improvements, under which condensed milk is still manufactured. Diplomas were also given by the American Institute, and a medal at the Crystal Palace, where the product competed for the first time with a foreign article in cakes. All this time Mr. Alden had also carried on experiments in the desiccation of vegetables and meats. Among other things, he concentrated eggs, and also egg-nogg and milk-punch, which sold well for sea service and tropical markets.

In 1858 Mr. Alden established the business of condensing and desiccating milk, meats, and vegetables at Newburgh. About this time Mr. Borden also entered the market with the product of

his factory at Amenia. Both establishments made, perhaps, six hundred quarts per day. To-day the business of eight or ten factories demands not less than fifty thousand quarts of natural milk per day, or fifteen millions a year, worth a million of dollars; engrossing, say, thirty thousand acres of land, using at least ten thousand cows, and supporting fifteen hundred men and their families. Yet all this is but the beginning of a single branch among the many into which the Alden Preserving Processes ramify. Of course credit is due to a number of inventors for important improvements, and to enterprising parties who have extended the manufacture and market for these products from time to time. But we must turn our attention from these to the ultimate and main development.

When the Rebellion broke out a heavy joint-stock concern was formed at Newburgh, the whole resources of which were engaged on Government contracts for the army and navy to the end of the war. At the end of this time Mr. Alden retired from business, but did not lay aside his cherished studies and experiments. He built and tried many different models of apparatus, and discovered by experiment and comparison the effects of evaporation by different methods upon a multitude of animal and vegetable substances. To make a long story short, in 1869 he had matured an apparatus and exact rules of proceeding in regard to a number of leading articles, which gave him satisfaction. The apparatus is simple and easily understood; but it is difficult to conceive the amount and cost of experiment by which the art of successfully applying the principle to so great a variety of products has been perfected.

Mr. Alden's intimate relation to the origin and past progress of the art of desiccation had not rendered him insensible to the unsatisfactory quality of its products. He was bent on producing a radically different result from that of desiccation so called, — a product that should be not only imperishable, but undistinguishable in any substantial sense from the fresh fruit or vegetable; and he rested not until, strange to say, he had realized this object in regard to some of the most important articles. Stranger still, this development of the original art had arrived of itself, in the most natural manner, at a stage where it proved to be an essentially novel art; not only distinct from, but opposite to, desiccation as practised, in its chemical principles and practical results. It turns out to be a process which not only forestalls decay, — that is the least of its merits, — but which in doing this at the same time carries out the organic process

of ripening to an artificial perfection, on the same principles incompletely used by Nature, and with a correspondent increase of the nutritive product. This remarkable instance, among others, goes far to convince us that when the Creator rested from his work it was only to put into his place a representative ordained to carry it onward; an intelligence entering into nature like a seventh creative impulse, destined ultimately to dominate every process, to wield every function at will, and to lead all things up to perfection.

The means employed by Mr. Alden to produce these results are threefold; namely, rapid circulation of air, accurately adapted and progressive warmth, and a certain proportion of humidity, — all of which are realized at once, in a very simple yet effective manner, from a single process. It will be noticed that each of these points stands directly contrary both to the process of desiccation or kiln-drying and to that of ordinary air-drying. In both the latter processes the circulation of air is, whatever may happen, and under any circumstances, insufficient to dry the fruit with proper rapidity; the temperature in the heated chamber is too high at certain stages, and in the common atmosphere too low, and in neither is it adapted to the changes in the progress of the fruit from wet to dry; and the same may be said of the humidity, which varies with the atmosphere from too little to too much, and is quite as likely to act most upon the fruit at the wrong stage as at the right.

In all forms of life, animated or vegetative, water is the circulating vehicle of life and growth until these are perfected, and then reverses its function and becomes the minister of death and decay. To absorb the water, therefore, is to stop the integrating or the disintegrating process, whichever may be going on, with equal certainty. The great absorbent is atmospheric air; and the only condition requisite for the instantaneous absorption of any amount of water is instantaneous contact with a sufficient amount of air. Nothing drinks like air. It soaks up water much more rapidly than sponge. The only difficulty is that its capacity for water is much less than its eager absorption would seem to promise. It is quickly satiated, soaked, wet through, and falls into an extremely forlorn and sticky condition, as everybody testifies in one of those "muggy" (murky) days, when the sluggish atmosphere hangs about us, loaded with the warm moisture it has drunk, and unable to move. In this condition, air, like a soaked sponge, so far from absorbing further moisture from objects in contact with it, only serves to keep them wet. To ob-

tain rapid and continuous evaporation, therefore, it is necessary to change the air rapidly, just as we should change sponges if in haste to soak up a puddle of water.

Such is the importance of this point that it makes all the difference between a partial and often entire decay of fruit, and that *perfect preservation of every particle* which keeps the product essentially fresh, and incapable of being distinguished, in confections for the table, from those prepared without previous evaporation of any kind. Pneumatic evaporation is therefore the appropriate general term by which the Alden process is designated. The substance to be freed of its water is exposed to a blast of rarefied air by a peculiar arrangement causing every particle of the surface (extended as much as possible) to be swept by a rapid succession of thirsty atmospheric particles, which drink off its moisture before the faintest symptom of decay can be manifested. The contrast of the result to the film of dark-colored rust (decayed matter) which covers the surface of all dried fruit and flavors it throughout, is very striking in the statement, but it is still more so in the tasting. No person not informed of the fact would suppose that a pie or sauce of Alden fruit was anything but fresh from the tree or the natural condition.

The action of the other two conditions — accurately adjusted and progressive temperature and humidity — is more occult and still more remarkable. In brief, it amounts to a continuation and completion of the ripening process of nature, precisely analogous, by chemical comparison, to that which takes place in the grape on the vine, and afterwards in the transition of the grape to the far sweeter raisin; or to that which takes place in the ripening of a Bartlett pear, which is picked in a hard and acrid condition, and afterwards matures spontaneously by itself into the most luscious and delicate of fruits. The term used to designate this new artificial process — which is really an advance upon Nature, carrying forward her own operation to a pitch to which she is unable usually to conduct it — is Supermaturation. Very few fruits are capable, like the Madeira grape, or the fig, of a spontaneous supermaturation. But the Alden process, by an application of the same genial influences of warmth and moisture which Nature uses, under conditions which at the same time arrest and prevent the least decay, is found by chemistry to have produced in fruits like the apple, peach, and tomato, for which Nature had done all she could, a large additional proportion of artificial saccharine matter, in place of cruder ingredients heretofore unimproved. There is no reason to doubt that all fruits and vege-

tables containing an unconverted residuum of mucous or starchy ingredients are subject to supermaturation by the Alden process, and will thus be enabled to develop an increased saccharine richness.

The proof of the fact of supermaturation, as above stated, is found in the remarkable sweetness of Alden apples, tomatoes, and other fruits and vegetables. Less than one half the sugar ordinarily required will make an Alden apple or pumpkin pie as rich as may be desired, and one must have a very sweet tooth who calls for sugar on Alden tomatoes. The testimony of chemical analysis is no less emphatic than that of the senses. From a variety of very careful comparative analyses conducted by Professor Stephen Krackowizer, of Vienna (now of New York), it appears that the usual increase of saccharine matter in Alden fruit, as compared with the same fruit in its original state, and also after being subjected to the most careful scientific desiccation, is not far from twenty-five per cent. At the same time this increase is chemically accounted for by an accurately corresponding diminution of the starchy ingredients which constitute the raw material of sugar in vegetation. The change is precisely the same as the natural progress of the fruit from green to ripe, carried onward with the same well-known improvement in wholesomeness, delicacy, and nutrition.

To attain this novel and invaluable result evidently required an exact experimental adaptation of the air-blast to every stage of evaporation in the fruit. At first, while fresh and wet on the surface, it must not encounter air that is either too warm or too dry. If too warm, the too rapid rarefaction and expansion of the latent vapor within the still copious juice will have the effect of congestion rather than circulation, crowding and perhaps breaking the cells. If too dry, the exposed surface mucus will dry too fast; that is, the dry air will lick up its water faster than that within can flow to the surface and take its place; and the result will be the sudden formation of a leathery cuticle which must impede both circulation and evaporation. After the whole mass has been *equably* reduced in moisture and raised in temperature, being kept all the time as nearly as possible alike in these respects throughout its texture, then it will bear, and even require for active circulation and evaporation, a warmer and less humid blast, to "hurry up" the attenuated remains of moisture through the nearly exhausted channels which now offer unobstructed exit. The exterior mucus itself, instead of drying to a tough film, will have been converted partly to sugar and water (aiding to keep the surface

in the moist condition peculiar to this process), and the surface will not toughen and thicken in the hot blast. The vapor from within passes freely through it, and keeps it still pliant, at a temperature of 160 degrees. In the pneumatic evaporator, therefore, the fruit usually enters where the blast comes out, reduced in temperature, and partly saturated with moisture from some twenty to forty layers of fruit already passed through. The fruit, being spread on screens, passes downward in the vertical pneumatic shaft or chamber, by regular time stages, meeting at every stage a warmer and less humid blast, until it reaches the bottom, and meets the blast as issued from the blower through a coil of hot steam-pipe, at the standard temperature ascertained for the proper maturing and curing of the particular fruit or vegetable in hand.

The part borne by humidity in this evaporating process — paradoxical as it seems — is remarkable and somewhat mysterious. An effect of the want of it in the dry heat of desiccation is noted by Professor Krackowizer in the presence of dextrine or starch gum peculiar to desiccated fruit. On the other hand, he notes the presence in Alden fruit of chemically bound water, or *hydrate*, in increased proportion, as a consequence of the humidity of the blast, which he thinks has an important chemical agency, as a "hydratic mediator." At the same time one result of this agency is that it really makes up for its moistening effect, and practically aids instead of hindering the prompt removal of the water. That is, it hydratizes (if we may so speak) a portion of the water, or chemically binds it, so that it is as harmless for decay as if it were actually removed. The result is sensibly apparent in the peculiar softness and moistness of all Alden fruit, — a moisture which is chemically bound and harmless, while it is of great value in preserving the flavor, richness, and fresh quality, and which could not be accounted for in fruit just issued from the hottest and driest part of the blast, except by the above explanation from the distinguished chemist referred to. It will be observed that this quality also preserves the fruit from the great changes in weight and condition which dried fruits undergo when the atmosphere changes from dry to damp, and *vice versa*.

Save the transformation of starchy ingredients to sugar, fruits and vegetables in the Alden process lose nothing but water, and gain no new ingredient to change their flavor or the character of their most delicate tissues. They return in water, after indefinite periods, to a condition scarcely distinguishable in any respect from their originals. The cells and granules swell to their original fulness, and not

only so, but to their original form and consistency. The microscope shows the structure to be intact in all its symmetry. It is crisp, tough, or tender, as its nature may require, entirely natural in odor and taste, and even the coloring matter is undisturbed. A spinach or lettuce leaf, for example, which had been reduced to the condition of a tea leaf, if again moistened, will afford to an uninitiated observer no evidence that it is anything but a leaf freshly plucked. It is not limp and dull, but crisp, bright, and green. So with a dish of cucumbers and onions, which yield up very large proportions of water and become shrivelled shavings. Moistened, full, crisp, succulent, and bright, the partial eye and tooth will find it just such a fresh salad as a June morning might be expected to bring, — and that in mid-winter, mid-ocean, or in the uttermost parts of the earth! A slice of squash or pumpkin as thin as a knife-blade becomes in water as thick as a finger. The summer squash becomes an all-the-year vegetable for every climate and market on the globe. A large load of pumpkins may be driven in from the field in the morning, and shipped to the antipodes at noon, in a barrel. The sweet potato, which perishes so rapidly as to be unknown to most of the markets of the world, is reduced to an imperishable condition by pneumatic evaporation, and will soon become a familiar luxury on the tables of the whole world, and at all seasons of the year alike. Its slices, placed in cold water and brought to a boil, for thirty minutes, are ready for the table or frying-pan, and in no respect inferior to the original vegetable. The northern potato, like the turnip, improves by evaporation, and for spring use, for ship-stores, and for exportation, leaves its original out of sight, occupies little room, and is proof against decay. Parsnips and carrots, grass and clover, prepared by pneumatic evaporation, will become practically new articles for fodder, fresh at all seasons and in all places. Cabbages, celery, salads, asparagus, greens, peas, lima beans, and other delicate vegetables, are no more to be identified in their perfection with a particular season, but will be the same at all times, and to the end of the earth and seas. Sweet corn is rejuvenated. If taken strictly in the milk, and treated before wilting, either on or off the cob, it will be as tender and sweet at the world's end as at the start. Green currants and gooseberries retain their favorite characteristics of flavor sealed up in them for travel and time. The same of the pie-plant. Forty pineapples have been compressed in a small cake which an infant might hold in its hand, and afterwards resurrected as forty pineapples again.

The Alden tomato is a remarkable product. No successful attempt had ever before been made to remove the condition of fermentation (water) from this fruit. The pneumatic evaporator reduces the whole pulp of the tomato to a condition like that of the dried fig. A bushel of the fruit, after evaporation, is compressed into a solid cube like plug tobacco, measuring four or five inches each way. Every pound of this makes eight quarts of tomatoes in the original state. Tomatoes may now be raised with advantage, like so many other things, wherever there is an Alden Evaporator at hand. It is impossible, within our limits, to glance at one half of the important applications of this great invention. To those named may be added all the small fruits and berries, grapes, plums, quinces, pears, etc. The application to meats, fish, and clams, is most satisfactory, more effective for preservation than salt, and nearly doubling both the nutritive value and the relish of the article, as compared with the method of salting, and with less cost. The drying of tobacco, glue, india-rubber, and many other articles, by pneumatic evaporation, will almost revolutionize the manufacture. The same of the beet-sugar manufacture, in which immense losses are suffered by the deterioration and decay of the root crop before it can be worked up. An analysis of the Alden beet has shown that the saccharine matter is preserved without diminution for years.

Mr. Alden's exhausting process, appropriate to the evaporated products, forms a distinct branch of business of first-class importance. The refuse of apples, peaches, etc., is rendered thereby as valuable as any part of the fruit; being first evaporated and then exhausted of the soluble matter, which is concentrated without boiling to solid jelly of the richest character, which will keep without sugar in any climate. The sweet potato and pumpkin, by the same process, yield a sirup surpassing the finest manufactured by our sugar-refiners, such as the Stuarts, alike for richness, delicacy, and lustre. The large profit of raising these vegetables for sirup will soon give them a leading place in the inventory of our national wealth.

All these products are prepared for market with little expense and with great rapidity. One evaporator, costing say $2,500 for the entire apparatus, will preserve one thousand bushels of fruit or vegetables per week, at a total cost of twenty-five to thirty cents per bushel. The apparatus consists of (1) an evaporating-chamber, usually of wood, five feet square and twenty feet high. 2. A revolving endless chain at each corner of the chamber, running vertically, and carrying

brackets nine inches apart to support the fruit-frames. 3. Twenty frames, or screens, of galvanized iron, on which the fruit is spread, each carrying about half a bushel. One of these frames of fruit is laid on its brackets once in four or five minutes, the chains revolve one stage (nine inches), and a finished frame is taken out at the bottom of the shaft while the fresh frame goes in and starts on its journey at the top. 4. Below the chamber a steam coil containing about three thousand feet of iron pipe, between which the blast from the blower passes to obtain its heat. 5. The blower. 6. The boiler and engine for driving the blower and supplying steam heat to the coil and thence to the air-blast. The fruit entering at the top is exposed at first to that part of the blast which has acquired most humidity and become reduced to a tepid temperature by its passage through the fruit below. This blast here takes off the surface moisture from the fruit rapidly enough to leave it no time to commence fermentation, but not so perfectly as to encrust it. At every prescribed interval the carrying chains move the whole series of fruit-frames downward in the chamber a given stage; being removed in a finished state at the bottom, as fast as they are introduced at the top. As the fruit descends, the blast becomes gradually warmer and freer from humidity, until its highest temperature is found at the lowest interval, where it is in most cases from 160 to 195 degrees Fahrenheit, according to the nature of the article in hand. It is not to be supposed, however, that the Alden blast is at any stage a *dry* blast. On the contrary, provision is made for imparting moisture to the blast at the beginning; and in some cases it is found advantageous to reverse the order, feeding in the fruit at the bottom and taking it off at the top.

SOAP; ITS HISTORY AND MANUFACTURE.

SOAP NOT REFERRED TO IN THE BIBLE. — INVENTED BY THE GAULS OR GERMANS. — KNOWN TO THE ROMANS AND GREEKS. — EARLY MANUFACTURES IN ITALY, SPAIN, FRANCE, AND ENGLAND. — WHAT SOAP DOES IS UNKNOWN. — SOAP IS CHEMICALLY A SALT. — EXTENT OF ITS MANUFACTURE. — PROCESS OF MAKING YELLOW SOAP. — DIFFERENT KINDS OF SOAP. — GREAT VARIETY OF MATERIALS EMPLOYED. — ATTEMPT TO MAKE SOAP FROM PETROLEUM. — ALUMINA AND OTHER THIRD INGREDIENTS. — SAPOLIO. — HISTORY OF THE HOUSE OF ENOCH MORGAN'S SONS.

THE word "soap" is found in two places in our "authorized version" of the Bible; namely, Jeremiah ii. 22, and Malachi iii. 2. The exact meaning of the Hebrew word, however, is not known, and the best authorities suppose that what is meant by it was, probably, the ashes of the glass-wort, a plant common in the dry parts of the East, and which may be used as a substitute for soap. Soap itself the Jews at that time had not. There is no reason, Sir J. G. Wilkinson says, for believing that the ancient Egyptians, from whom the Jews derived so much of their civilization, knew or used it. Nitre, or a lye from the ashes of glass-wort and similar plants, or the juice of saponaceous plants, was used instead. So was fuller's earth, and so was mere washing in water, accompanied by rubbing or stamping.

Soap, as we now know it, appears to have been a barbarous rather than a civilized invention, and to have been discovered by the Gauls or Germans, or both, before the Christian Era. Soft soap was apparently made before hard soap, as a potash lye from the ashes of trees was at first used, and not soda. From these barbarians the Romans learned to make it, and from the Romans, the Greeks, — an order of introduction the reverse of that which commonly prevails. Some kind of soap — probably a pretty caustic kind of soft soap — was used by the Roman ladies to dye their hair red or yellow. Soap was found in one of the houses of Pompeii (destroyed A. D. 79); so that it was pretty quickly and generally adopted by the most civilized people of ancient times after they became acquainted with it.

No records appear to be known of the continuance of the manufacture of soap during the first seven centuries of the Christian Era,

though it is extremely probable that it was constantly made. There is, however, good authority to prove the existence of soap manufactories in Italy and Spain in the eighth century. About the twelfth the business was established at Marseilles, that part of France affording olive oil and soda, two excellent materials, and soap has been made there ever since. Within two centuries afterwards the business was begun in England, and Bristol furnished most of that country with it for a long time, at a cost of one penny a pound. In 1524 the first was made in London.

It is a curious fact, that although we know very well what soap is used for, and what it does, we do not know how it does it.

The usual statement made on the subject is this: Soap, consisting of fat and alkali, removes grease or other dirt by surrendering, when dissolved in water, part of its alkali, which thereupon proceeds to combine with the grease or dirt, forming a new material, or additional portion of soapy matter, which water will remove. But if this were the case, the "part of the alkali" all alone would do the business. We do not send a hundred men to bring a parcel, of whom one brings it, after all.

Soap is a chemical compound, and is, chemically speaking, a "salt," resulting from the combination of an acid with an alkali. The acid is a "fatty acid," namely, stearic, margaric, oleic, etc.; the alkali is almost universally either soda, which makes hard soap, or potash, which makes soft soap. And soap-making is simply conducting this combination of the acid and alkali.

A few figures will show how important the soap business is. At Marseilles alone not less than one hundred and thirty-five millions of pounds of soap are made each year. In 1860 more than six million three hundred thousand dollars were invested in soap and candle factories in the United States, turning out about eighteen and a half millions of dollars' worth annually of the manufactured articles, without including in this total value a very great quantity of home-made soft soap. In 1852 there were made in only eighty towns of Great Britain (not including Ireland) more than one hundred and five millions of pounds of soap.

Until the present century, soap had always been made, to use a common expression, by "rule of thumb"; that is, according to the practice which had grown up in one or another locality. The first important scientific epoch in the history of the business was the introduction of a mode of making artificial soda in the beginning of this century by Leblanc, who thus supplied to Marseilles the want

caused by the war with Spain, which cut off the usual importations of barilla. Not long afterwards the celebrated French chemist Chevreul made a series of investigations into oils and fats, being the second important scientific epoch in the history of soap, and which resulted in placing the business of making both soap and candles on a really scientific basis.

The best and clearest account of the process of soap-making will be given by following it through the works of a large and scientifically, as well as successfully, conducted factory. For the purpose of accomplishing this object, the old established firm of Enoch Morgan's Sons, of New York City, was visited, and the materials followed from the pan to the package, with constant explanations from one of the members of the firm, himself a practical chemist and a practical manufacturer. For the present purpose, it may be supposed that the article to be made is the common yellow or bar soap; and what is sought is neither a strictly scientific statement, nor a fulness of information that would enable the reader to build and run a soap-factory for himself, but a plain and readable account of the operations.

Filling the central part of the first floor of the factory of Enoch Morgan's Sons, near the foot of Bank Street, in New York, is a range of four or five immense iron structures called pans. These extend from the floor through the ceiling, and breast high into the room above. They are twelve or fifteen feet wide and of about the same depth, and will hold, if filled to the brim, about one hundred thousand pounds each, or, some eleven or twelve thousand gallons.

The first thing to do is to prepare some lye; that is, a solution of caustic soda in water. This is done by the action of fresh-slacked lime, which, on being mixed with carbonate of soda in water, seizes the carbonic acid, becomes a carbonate of lime, and leaves the soda in its caustic state dissolved in the water. Several different portions of this lye are prepared, varying in strength.

Next comes "pasting," which is the first union of the materials into a soap-like form. It is accomplished by repeatedly and slowly boiling refined white tallow, first with the weakest and then with stronger and stronger lyes. At each boiling, a successive portion of the tallow divides into its constituents of oleic and stearic acids and glycerine. The former, which are "fatty acids," combine with the soda from the lye, and the glycerine drains out and mixes into the water of the lye. After each boiling the pan is allowed to settle; the light soap material rises to the top, and the heavy "spent lye" and gly-

cerine sink to the bottom, and are drawn off, when more lye is added and the process repeated.

"Pasting" is complete when the grease is thoroughly "killed"; that is, when soda enough has united with the stearine to separate all the glycerine; which of course makes an end of the grease, and puts soap in its place. The new material consists of little yellowish grains (the soap) floating on the liquid of the "spent lye."

After pasting is complete, a third or fourth as much resin as there was tallow is added in coarse powder, and stirred in. The effect of the resin is to improve the yellow color of the soap, to make it more uniform in texture, and softer and easier of solution in water.

The next process is to add an excess of solution of caustic soda over what is necessary to thoroughly saponify the grease and resin. After settling, this excess is run off, and the soap is now ready for finishing. This finishing is done by thinning down the soap by heat and adding water to it until the heavy impurities sink to the bottom, while the light ones rise to the top. Upon once more settling the pan, the soap collects in the upper part of it, not now in the grained state of the "paste," but in a clear, uniform, semi-transparent molasses-like fluid. On the top floats a scum a few inches thick, which the workmen call the "fob"; it is yellow and light of structure, with foam-white scales and light impurities about it. Down below, in the bottom of the pan, is the heavy sullen mass of spent lye, and next above it a layer of imperfect soap, containing a certain portion of impurities, and which is called by the workman the "nigger." The word appears to be quite an old one, and to be a true derivative from the Latin *niger*, black, as the stuff itself is dark colored.

As soon as the soap is cool enough, and before it is too cool, it is ladled out of the pan into "frames." These are in the form of a large deep bureau-drawer set up edgeways, and each will hold about twelve hundred pounds of soap. They are open, however, at the top, corresponding with what would be the front of the drawer. They were formerly made by laying square wooden frames one above the other, somewhat as a log-cabin is built, but are at present usually of iron, which cools much faster.

When cool, the iron frame is removed, and the great lump of soap — also called a frame — is left standing naked all by itself. While still soft and helpless it is slit horizontally into slabs; these are cut perpendicularly into bars, and these bars, whose length represents the thickness of the frame, are the well-known "bar soap."

SOAP MANUFACTORY OF E. MORGAN'S SONS.
(Inside View.)

Swiftly the stamp of "Enoch Morgan's Sons" is spatted upon the top of the upper layer of bars; they are laid into a box; spat, spat, spat, goes the stamp again, and the next layer is packed; and in a few minutes the whole twelve hundred pounds are boxed, nailed, labelled, and ready for shipment.

It must not be supposed that this is the only soap made by the firm, by any means. The number of kinds and styles is very considerable, and, from the great number of different practicable combinations of materials and variations of process, can be increased almost without limit. Thus, the house of Enoch Morgan's Sons not only manufactures large quantities of the yellow or bar soap, which we have been following through the process of its manufacture, but regularly supplies other kinds. For instance may be mentioned the "mottled soap," usually termed Castile soap, probably from having been first made in Spain, where the soap business was very ancient. This mottling is accomplished by keeping the soap thick, so that the "nigger" cannot fall down through it to the bottom, but has to gather into streaks and veins throughout its substance, the purer and whiter soap doing the same. If the coloring matter thus supplied is not sufficient, a proper quantity of oxide of iron is added. This mottled soap is a harder and better article than the resin soap, and dissolves more slowly in water. Again, the firm makes a soap with cocoa oil, which is hard, light, and will wash with salt water. This is well known as "salt-water soap," or "marine soap." It is unnecessary to enumerate further.

Many different materials are used in making soaps, and many modifications of the process above described are employed, — some cold, some hot, some under pressure, etc.; but they all come under the one brief statement of a chemical union of caustic alkali with the acid part of a fat or oil. Tallow, suet, butter, spermaceti, whale oil, fish oil, goose-grease, horse-fat, and many more, have all been used. Even human fat has been made into soap, which, Professor Dussauce says, "dries quickly, and turns yellow." An equal or greater number of vegetable oils have been tried, including olive oil, linseed oil, nut oil, poppy-seed oil, castor oil, sunflower-seed oil, cotton-seed oil, cocoa and palm oils, etc., and quite a number of these different fats and oils have not only been manufactured experimentally, but are regularly used in the business. Even turpentine, wax, and resin, with alkalies, will form soaps, though not very good ones. Among the numerous improvements that have been devised in soap-making have been a number of plans for making

soaps from petroleum. The blunder of expecting a soap from petroleum because it is greasy is a good deal like expecting that alcohol will put out a fire because it is a fluid. That which combines with the alkali must be an acid; to be such an acid, it must have oxygen in it. Now there is no oxygen in petroleum, and therefore it has not in it what can make soap.

The variety of alkalies available for soap-making is not so great as that of oils, and it can hardly be said that any besides soda and potash are commercially used in the business. There exists a process for using, instead of soda, an "aluminate of soda," consisting of nearly equal quantities of alumina and soda, which is claimed to give a soap of much greater cleansing power than soda alone. Ammonia has been employed as the alkali of a soap for medical use. Lime or baryta, being alkaline earths, will make soap. Some metallic oxides will do so; and a soap made by boiling olive oil with oxide of lead is known as "lead soap," and is used in medicine, as is a so-called "arsenical soap."

A certain number of other matters are used like the alumina just mentioned as *third ingredients* in soap, besides coloring matters and scents. Adulterations of many kinds have been practised, not merely by mixing cheap oils with costly ones, and the like, but by adding mashed potatoes, or starch, or fine clay, or marble dust, or sulphate of baryta, to tallow, or to the soap itself.

Several materials have, however, been avowedly and openly mixed with soaps as improvements. The use of resin has been described. Silex, either as sand or in the form of "water-glass," or soluble glass (silicate of soda), is one of the most common; and some of the soaps made in this way are extremely efficient and useful. Modified soaps for various special purposes are made by mixing lime water, dissolved alum, etc., with soap already made.

One of the best known of all these modifications of soap is that known as "Sapolio," invented and introduced by the firm of Enoch Morgan's Sons, already referred to. This is a refined hard white soap, with which, at a certain stage in the process, a very finely divided powder is incorporated, the result being a material possessed of an extraordinary union of chemical and mechanical cleansing powers. It is intended not so much for purifying cloths as for cleaning paint, woodwork, brass, copper, windows, statuary, machinery, oilcloth, polishing bright surfaces, etc., and its nature is such as to require a particular mode of application; but if the printed directions are complied with it has extraordinary efficacy. It has,

however, been used with much success for removing grease-spots from clothes, etc., — a quality which was brought before the public once, and discovered twice, by a sort of accident. When the Sapolio was first introduced, and all the force of the house of Enoch Morgan's Sons had their hands and heads full to overflowing with making it and talking of its virtues, one of their employees, on going home one evening, found his wife at her wits'-end over a desperate grease-spot on the clothes of her son. "Pshaw!" exclaimed the father, half vexed and half joking, and recurring to what had been praised in his hearing all day as equal to almost everything, from purifying an evil conscience down to scouring paint, — "pshaw! Try Sapolio!" The mother promptly did so, and the Sapolio promptly took out the grease. This was reported at head-quarters next day, but not much notice was taken of it until, at a subsequent period, Rev. Henry Ward Beecher published in his newspaper a strongly worded commendation of the Sapolio for the very same good quality, which, it seems, he had discovered very much in the same way. "You might go and ask Beecher for a recommendation till the day of judgment, you know, and not get it," observed the gentleman who told this story; "and so we think that recommendation means something."

Like many of the soundest firms in New York, the house of Enoch Morgan's Sons has quite a history. It was founded by the maternal grandfather of the present partners, Mr. D. R. Williams, about sixty years ago, at the same site now occupied by their down-town store, No. 211 Washington Street. The business has thus descended directly and prosperously to the third generation of hereditary owners, and seems likely to stand as much longer. In the days of its origin soap and candles were commonly manufactured at the same establishment, the fats used being applicable for either purpose. The making of candles was kept up until some ten or fifteen years ago, when the use of those ancient artificial lights had become so diminished, in consequence of the introduction of gas, burning-fluid, kerosene, etc., that it was given up, and the only work done at present by the firm besides soap-making is the preparation by wholesale of a few chemicals, where the processes can be so carried on as to combine economically with the soap processes.

IRON WORKING MACHINERY.

THE IRON AGE. — THE SPIRIT OF MODERN INDUSTRY. — THE WORKING OF IRON. — MESSRS. WOOD, LIGHT AND CO. — THEIR CONTRIBUTIONS TO THIS ART. — THEIR IMPROVED BOLT CUTTER. — A DESCRIPTION OF ITS WORKING. — THE DOUBLE MILLING MACHINE. — INVENTED BY MR. WOOD. — A DESCRIPTION OF IT. — AN AUTOMATIC SHAFTING LATHE, INVENTED BY MR. WOOD. — ITS ADVANTAGES DESCRIBED. — A CUTTING-OFF AND CENTRING MACHINE, INVENTED BY MR. WOOD. — ITS OPERATION DESCRIBED. — PLANING IRON. — THE WARREN PATENT SHAPING MACHINE, INVENTED BY MR. WARREN. — A DESCRIPTION OF ITS ADVANTAGES. — THE DOWN FEEDER. — IMPROVEMENTS ON THE SLOTTING MACHINE.

In the classification of the eras of social advance, the present age may well be called the iron age. The most widely diffused of the metals, forming, as it does, a constituent part of almost everything we see about us in the material world, iron has, in the present age, become the most important adjunct of the industrial advance which characterizes the present century.

By the slow but sure process of generations, mankind has come to learn that our position in nature is dependent upon ourselves, and that only as we apply ourselves can we obtain control over the conditions in which we are placed. As a corollary of the advance which the philosophy of the present day has made over the metaphysical vagaries of the past, the industry of the present era has partaken of the same positive spirit, and by observation and experiment has obtained the ability to perform operations which formerly appeared out of the reach of human capacity.

In hardly any other special branch of industry is this shown more thoroughly than in the working of iron. The ingenuity of the inventors has kept pace with the increasing requirements for new processes to meet the new demands, and the increasing necessity for economy of time in the greater activity of our industrial life. At the present day the application of machinery to the working of iron has become almost universal, and the preparation of such

machinery a special branch of industry of great and growing importance.

Among the numerous firms engaged in this specialty, that of Messrs. Wood, Light & Co., of Worcester, Massachusetts, may be justly selected as especially representative. Not only does this firm hold this position from the importance of their business, and its deserved reputation, but also from the fact that the members composing it have, by their various inventions, done much towards extending the application of machinery to the working in iron, and opening new fields for the use of iron in the arts. Being themselves practical mechanics, and having a knowledge, from experience, of what was needed in the application of machinery to the working of iron, the members of this firm have been enabled to devote their inventive talents to supplying the wants universally felt for improvements in certain directions, while the reception their inventions have met, is a proof of the general existence of the want they have supplied.

At their establishment in Worcester, Massachusetts, they have the appliances for making any and every kind of machinery, though their business is chiefly confined to certain specialties, which they control, as they own the patents. A description of some of these will show the character of the modern appliances for working iron.

First we will mention an improved bolt cutter, the patent right to which they control. This simply constructed but ingenious machine is a great improvement upon the methods formerly in use. Its chief features are four movable dies placed in an adjustable holder, and, by a simple and durable arrangement, opened and closed by the automatic action of the machine, or by hand if necessary. For all square-headed bolts it has a holder into which a bolt can be put, or from which it can be removed, in an instant, without the use of a screw or wrench. When the bolt is placed in the holder and moved forward until it meets the dies, a lever on the front of the machine is pressed down, the bolt enters the holder and is carried on by the action of the machine until the threads are cut into the desired length. Then an adjustable rod lifts a latch, and a hand falls into a notch and holds a cam, while the dies revolve and are instantly opened, as a cam on the driving gear presses a rod against the bolt holder, and the bolt is released and thrown out of the dies, which are then ready for repeating the process upon another bolt.

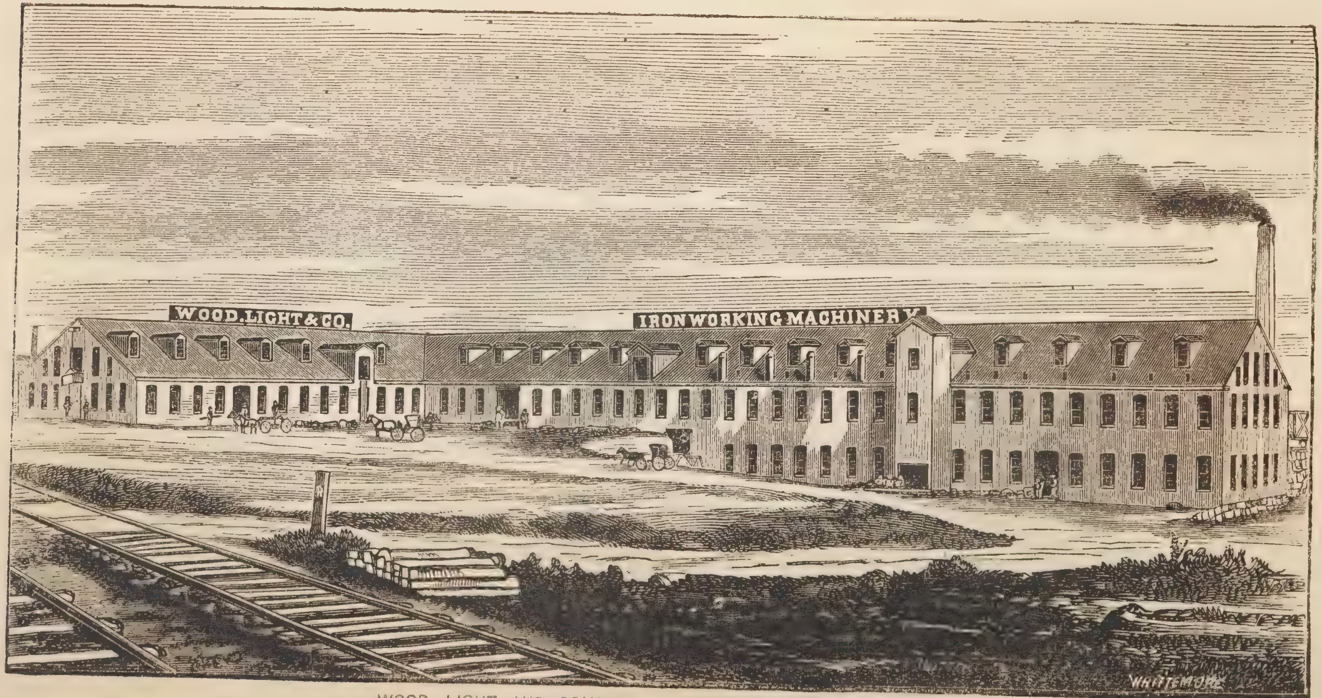
The dies and die-holders are all made to fit a steel templet, and are drilled and tapped in a machine, in every respect exactly alike. The holders in every machine are so made that several sets of dies will work equally well in them, so that the operator can supply himself with dies of any required size from the manufacturer, at a cheaper rate than they could be made by any one else not having the same facilities.

In this machine the size of the thread on the bolts may be instantaneously adjusted to any variation in the nut. The machine is entirely automatic, requiring only to be "fed," when it performs its work with more accuracy than could be done by hand. When the dies of the machine become worn and dulled, they may be annealed and re-set in the machine, and re-cut in place, the ingenious device by which the dies are made to accommodate themselves to the different sizes of the bolts, acting now to adjust the dies themselves, made shorter by the process of re-cutting, so that in relation to each other the aperture between them shall be no longer than it was before. In this way the difficulty attending the wearing away of the dies, and the shortening of the die plates by repeated re-cutting, is overcome, and the dies are made useful until their substance is worn away.

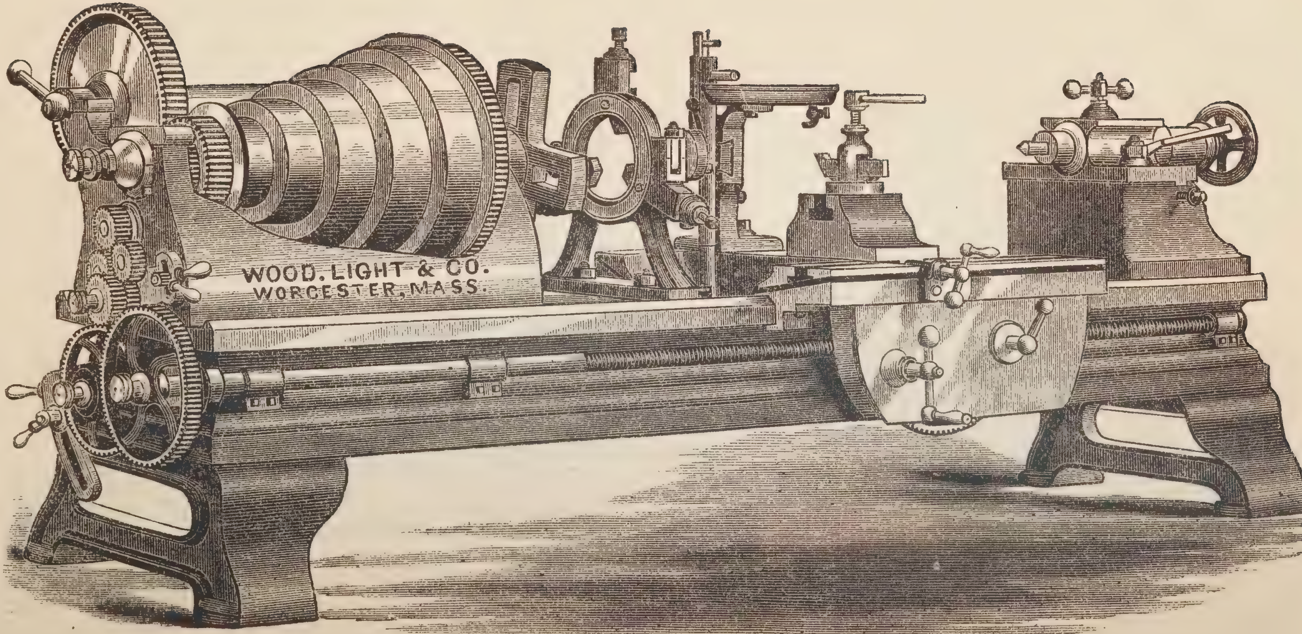
Another machine manufactured by Messrs. Wood, Light & Co. is a double milling machine, which was recently invented and patented by Mr. Wood. This machine is already in great demand among manufacturers, since it not only accomplishes twice as much as a single milling machine, but performs it with greater accuracy. It is found to be of especial importance in the milling of gun work, and in the manufacture of sewing machines, besides a thousand other branches of industry to which its rapidity of work and convenience make it peculiarly applicable.

Another invention by Mr. Wood, and which is manufactured by the firm, is an automatic shafting lathe. This lathe is noticeable not only for the principle upon which it is constructed, but also for the amount of work it will do, as it will turn thirty feet of two-inch shafting an hour, which is fully four times as much as any ordinary lathe can do.

The great difficulty in turning iron rapidly arises from the heat generated by friction in the iron worked, and also in the cutting tool, the temper of which is destroyed if the work is driven fast enough to make its heat excessive. To overcome this difficulty, turners in iron have been accustomed to use water for the purpose



WOOD, LIGHT AND COMPANY'S MANUFACTORY; WORCESTER, MASS.



IMPROVED PATENT AXLE LATHE.

of keeping the cutting tool cool, allowing it to drip continually upon the iron.

This invention, however, for the purpose of avoiding this difficulty, is much more effective. It consists in making the bed of the lathe, through its entire length, a trough, or open tank, which is kept nearly filled with water impregnated with soda, and which is constantly distributed over the shafting by pumps worked by the same power that works the cutting tools. Of these tools, three are kept in operation at the same time, being placed in line, the first cutting off the "scaling chip," the second removing the next layer of "chips," and the third finishing the work.

This lathe is also so constructed that the soda water is never dashed or sprinkled over the sides of the tank, though it is pumped continually upon the work, so that the floor under the tank is kept constantly perfectly dry. This practical consideration for the health and comfort of the workmen is well worthy of notice.

Another invention to use with this consists of a "cutting-off and centring machine." This ingenious piece of mechanism cuts off and centres shafting in order to prepare it for turning. This has heretofore been a tedious operation, which has frequently been performed unsuccessfully, but by this machine it is accomplished regularly, easily, and in a scientific manner. The machine consists of a hollow cylinder, or "spindle," made to revolve on its bearings, and having at each end a "scroll chuck," by which the shafting, or work to be cut and centred, is confined centrally with perfect precision. The shafting is then cut off at exact right angles to its length, when by a most ingenious combination of gearing exactly graduated to the work to be done, the shafting is centred and counter-sunk ready for turning. The whole of this work — cutting, centring, and counter-sinking — requiring by this machine not a sixth part of the time consumed in accomplishing the same results by the old methods, while also by this machine the entire series of operations are accurately performed by unskilled labor; any one who can turn a crank being able to put the shafting in proper position, and the setting of the centring tool requiring only a simple motion of the hand.

In the process of planing iron, which has come to be so generally used, great improvements have been introduced by this firm. The largest planing machine in the United States is in the Navy Yard at Charlestown, Massachusetts, in which a piece of iron forty-two feet long by twenty-five wide can be planed.

The iron planer is generally a machine consisting of a long bed-piece supported by legs, upon which a movable table rests, and which is worked by cog-wheel machinery underneath the table. Above the table, and fixed to the bed-piece, rises what is known as an "upright," on which is arranged a cross-bar, so adjusted to the upright as to be able to move up and down, accommodating itself to the thickness of the iron to be planed. The iron is placed upon the table, and this being moved as required along the bed-plate, brings the iron under the knife, or planer, which is affixed to the cross-bar.

Planers of this kind are known as rack-feed planers, in contradistinction to the old chain-feed planers, both names being derived from the appliance by which the table is moved, either with cogs or with a chain.

An improved planer manufactured by Messrs. Wood, Light & Co. is known as the Warren Patent Shaping Machine, and is the invention of Mr. William H. Warren, in the employ of this firm, and was patented in 1868, and again in 1871. Its manufacture already forms an important part of the production of this vast industrial establishment.

In the old style of planers many difficulties remained unsurmounted. They were unable to plane, without great trouble, many forms of iron; or, if a long piece of iron was to be planed, and was laid upon the table cross-wise, that portion of it which projected over the table needed to be propped up with care. Otherwise there was constant danger lest it should tip up the table, raising it from the grooves in which it slides, and thus disarrange the planer. It was also almost impossible with the old style of planer to plane the iron regularly. Another important objection against the old form is, that it did not sufficiently economize time, since one half of the time spent in the operation was lost while the table was returning to its original position after having passed the iron under the tool.

This was particularly the case when large pieces were to be planed. Besides, too, the old planers were adjusted to only one rate of speed, and could not plane small pieces of iron proportionally faster than large ones. This will appear more forcibly when it is considered that in planing a short piece the machine has to run back oftener than in planing a long one, each return being so much loss of time.

In undertaking to practically obviate these objections, a

machine is produced in which a piece of iron of any size, or any form or shape, whether circular, angular, or what not, can be planed. His improved planer consists of a bed-piece resting upon legs, upon which is fixed a "shoe," so called, in which is adjusted a "sliding ram," which holds at its head the cutting tool. This ram is made to move forward by eccentric machinery, of the crank-motion kind, carrying the tool over the work to be planed, instead of the work being carried under the stationary cutting tool, as in the old form. By this improved method the desirable end is gained of causing the cutting tool, after it has accomplished its work, or gone as far as it can reach, to return suddenly to its original position, thus saving about forty per cent. of the time heretofore occupied in planing a given piece of iron.

The inventor has also added a device by which the stroke of the cutting tool can be made long or short, or light or heavy, at the option of the operator who guides it, and this while the machine is in operation, no time being thus lost in adjusting the tool. By this improvement, any portion of a piece of iron requiring to be planed can be subjected to the action of the tool, while another portion of the same piece may be left untouched. The machine is also automatic, and may be left to do any regular piece of work itself, without any fear of its making a mistake.

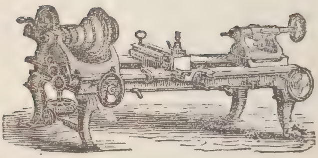
To the side of the bed-plate is fixed a sliding table upon which the piece of iron to be planed is placed, and which gradually moves by regulated machinery so as to push the piece to be planed sidewise under the cutting tool. By a device of cogs and a table crank, invented by him, this sliding table is rapidly put back to its starting-point, after having once run to its end along the bed-piece, thus again saving a large proportion of time.

The machine is also supplied with a most ingenious, though seemingly complicated device, by which what is called the "down feed" is effected automatically, thus saving the time of the workman and securing greater evenness in the work. This "down feeder," or "angular feeder," as it is also called, is automatic at any point or angle. The side sliding table, on which the work is placed, is moved up and down, to suit the work to be planed, by a perpendicular screw operating in a novel way, by which much time is saved to the workman.

The machine is, in short, one of the most noticeable triumphs of invention in the department of constructive machinery, and being controlled by Messrs. Wood, Light & Co., gives them great

industrial advantages. Mr. Warren has also patented improvements upon the slotting machine manufactured by this firm, by which " a positive, automatic, total relief of the cutting tool when on its return " is secured, thus preventing the wearing of the tool and the roughening of the work, while at the same time making the positive cutting of the tool more accurate and smooth than by any former process.

These improvements accomplish a saving in the operation of slotting machines estimated at fully forty per cent. With these improvements, the position of the ram and the length of the stroke are both adjusted while the machine is in operation, whereas to accomplish either of these things formerly required the stopping of the machine, and a consequent loss of time. This slotting machine is a most convenient tool to have in a machine shop, it being adapted not only to slotting proper, but to planing at any angle, or circularly, or in any other form, as, for example, the strap for connecting rods, which presents in its surface curves, circles, planes, right angles, inner and outer planes and edges.



AGRICULTURAL HAND IMPLEMENTS.

THE INTRODUCTION OF MACHINERY INTO AGRICULTURE. — THE NECESSITY OF HAND IMPLEMENTS. — THE APPLICATION OF MACHINERY TO THEIR PRODUCTION. — THE IMPROVEMENTS MADE IN THEM. — THE AUBURN MANUFACTURING COMPANY. — THE VARIETY OF THEIR WARES. — THEIR BUSINESS FACILITIES. — PROCESS OF SCYTHE MAKING. — SOCKET HOES AND EYE HOES. — HOOKS AND FORKS OF ALL KINDS. — RAKES. — WOODEN AGRICULTURAL IMPLEMENTS. — POTATO DIGGERS. — BRANCH ESTABLISHMENT IN NEW YORK. — THE COMPANY'S WORKS. — THE EXTENT OF THEIR BUSINESS. — THE REASON FOR THEIR REPUTATION.

THE importance of the manufacture of agricultural implements in this country is too evident to be insisted upon here. Despite, too, the application of machinery to agriculture, there is, and most probably always will be, a necessity for performing many of the operations by hand, and the preparation of the implements for doing this work is one of the chief industries of the country. In this department of industry, as in almost every other, this century has been marked by great improvements in the style of the implements used, by the application of machinery to the process of their manufacture, and by the cheapening of their price, resulting from the industrial organization of the business, in accordance with the new demands of the present phase of civilization.

One of the chief establishments for the manufacture of hand agricultural implements in the United States is the Auburn Manufacturing Company, situated at Auburn, N. Y. Among the articles they manufacture, the following, selected from their price list, will give an idea of the variety of tools which modern invention has designed for facilitating the operations of agriculture: Grain scythes, grass scythes, bush or bramble scythes, hay knives, straw knives, western corn knives, manure forks, hay and straw forks, spading forks, socket and shank hoes, rakes, potato hooks, manure drags, potato diggers, weeding hoes, cast steel garden rakes, planters' eye hoes, etc., etc.

The location of the Auburn Manufacturing Company's works, at a never-failing water power furnished by Owasco Lake, enables them to obtain the power for carrying on their operations at the cheapest rate, while the junction of the New York Central and Southern Central Railways, which lies in close proximity to their establishment, enables them to enjoy every facility for receiving their material and forwarding their goods to all parts of the country with the least expense, and to this fact, together with the advantages of healthful climate, increasing market, cheap fuel, and extensive application of improved machinery, directed by experienced and competent managers, is mainly due their eminent success; and when it is considered that not one fourth of the arable land in the country is in cultivation, and that the new states are so rapidly increasing in population, it is easy to calculate what *will be* the demand for agricultural hand tools. Two water wheels are in use, the aggregate capacity of which is four hundred horse power.

The material used by the Auburn Company in the production of their wares is the best to be obtained; that used in the scythes is the best Swedish iron. This is received in bars, which are welded to steel under trip hammers, and cut into the proper lengths for the rolls. The rods thus prepared are then placed under heavy rollers and lengthened to the required size. After this process they are placed under a plating hammer and shaped out. The plates are now placed under a "back turning machine," which bends them on the back edge, forming the stiff ridge along the back, and giving them the requisite stiffness and strength. They are next placed under a trip hammer to receive the "set" or inclination of the back to the guard plate, by which the scythe is further stiffened. The heel of the scythe is then turned by the use of dies and a gauge, in order to insure accuracy and uniformity. The scythe is then pointed properly by hand, the blade being heated to a red heat, and hammered by hand to a point. The next process is hardening the scythes. The blades are placed in an oven, over a blazing fire, and heated to a red heat, and then taken out and plunged into a tank of pure water, into which a constant supply is kept running, so that the temperature of the water is kept always the same. Next the scythes are tempered, some of the hardness being removed. The temperer also straightens the scythes at the same time. The scythes are now ground upon large Nova Scotia

grindstones. These stones are one foot thick and seven feet in diameter, weighing about six thousand pounds each, and are driven at the rate of about two hundred or more revolutions in a minute. By means of these the edges are ground and polished, while the backs are ground in a machine, in order to insure uniformity of work. The scythes when thus fashioned are taken to the inspecting room, where they are submitted to a test as to temper, and if approved, pass to the polishing room, where, upon emery wheels, they are polished to perfect brightness.

In this process of polishing, a great variety of wheels are employed, differing in the fineness of the emery used according to the character of the work required. The scythes when polished are painted, as the case may be, of various colors — red, green, or blue, or bronzed. The bronzing is done on the highest priced scythes. The processes of manufacture of machetes, or knives for cutting sugar-cane, and of corn and straw knives, are substantially the same as those in making scythes; the varieties in the various forms of these different utensils, by which they are fitted to the better performance of the work to which they are specially designed, necessitating but slight differences in the process.

The corn knives are largely used in the West — Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, the great corn producing states of the Union, ordering large quantities of them. Of these corn knives there are four varieties made by the Auburn Manufacturing Company, while of the hay knives there are five, of the bush scythes five, and of the grass scythes over sixty. The scythes are boxed, or strawed — that is, wound up in ropes of straw — for market, according to the orders for them: the hay, straw, and corn knife handles being all made on the premises.

In making socket hoes, the steel is received in bars from the rolling mill, which are then heated and put under a press, which strikes off a "pattern," that is, enough to make a hoe with its shank. To the shank a socket is afterwards welded, in which the handle is finally fixed. The "pattern" is then spread, that is, is heated and hammered under a trip hammer to the proper width for the hoes. Then, heated again to a red heat, it is placed under the rollers, controlled by screw gauges, and pressed into the proper thickness and depth. The plate thus spread is of an irregular form, and is then put under a die, of the size of the hoe to be made, and by one stroke its edges are trimmed evenly. It is then heated

again, and put under a drop with concave and convex dies, and given, by a blow, the required concave. It is then hardened by being immersed while hot in whale oil, which gives it the trowel temper desirable in this class of goods. The hoes are then properly "burred," or, as this term indicates, the edges at the place where the blade unites with the shank are cut or ground away even and smooth. This process is performed upon a wrought iron wheel, which revolves at the rate of two thousand revolutions a minute. Then the hoes are finished by being ground and polished.

The advantage of "pressing" the plate between rollers is found to be, that this process gives the hoe a uniform, smooth surface, which is not attainable by hammering. It is also found that there is a great saving in the material in thus having them of uniform thickness, since the grinding and polishing processes are greatly lessened, and a great saving in labor is thus attained. Besides this, in tempering, —which is a most important matter, — plates of uniform thickness receive a more even temper than those of unequal thickness.

Shank hoes are made by the same process as socket hoes. The only difference being in the omission of the socket. The hoes are then handled and made ready for market. The handles are made of second growth white ash. The Auburn Manufacturing Company makes all the handles for its implements, with the exception of some three hundred thousand a year with which they are supplied by handle makers.

Eye hoes are such as have an eye for the reception of the handle. They are also generally called "Planter's hoes," from the fact that the chief market for them has been in the South and South-west, for use on the plantations. The eyes are made by the old process of "drawing out," and welding by hand. The blades are, however, trip-hammered, and rolled by a process similar to that used for the socket hoe. The blades of eye hoes are not usually made entirely of steel. The "pattern" of iron is "laid" with a hammered steel blade, thus giving strength and sharp edges.

Potato hooks, manure, hay, straw, and sluice forks (these last being used for cleaning out the sluices and other work in gold mining), spading forks, and other kinds, are manufactured also by the Auburn Manufacturing Company in larger variety than by any other establishment in the country.

Forks are made of steel, cut from the bar into pieces of suitable length, which are then heated to red heat, and "shanked," and "split," and "turned out" under a machine of ingenious construction, which roughly shapes out the fork, giving it as many crude "tines" or prongs as are required. The use of this machine secures a saving of at least fifty per cent. of labor and fuel over the old process. The tines are then drawn out by trip hammers, the faces of which are dies of the requisite shape and size. Its outward shape is then given to the fork, and it is heated in an oven so constructed that the heat is only imparted to the steel, while the effect of the vapor of sulphur, which is injurious to the steel, is avoided. This is a great improvement over the old method of laying the tines on the bed of coals. The furnace is divided from the oven by fire brick. Then the forks are put through the "formers," which give them the required shape, and while still hot, are immersed in whale oil, and afterwards tempered in a composition of melted lead and tin. They are then ready to be polished, handled, and prepared for market.

The Auburn Manufacturing Company makes also all the ferrules used, and also all the dies for all classes and kinds of its work, as well as all its smaller machinery. The steel garden and lawn rakes are made by processes similar to those by which the forks are made. The rakes of their manufacture can be seen in use at the Central Park in New York city.

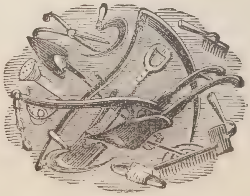
The wood implements consist of a general assortment of grain cradles, scythe snaths, hand rakes, and other agricultural utensils of this material. Another ingenious implement which is manufactured by the Auburn Manufacturing Company is a potato digger. This implement is arranged with a sort of movable arm to serve as a fulcrum, and the potatoes in the hill are at one operation raised from the dirt, and brought out from the ground clean and together. Though very efficacious in its working, yet the cost of manufacturing them prevents such an extended sale as would justify their production in large numbers, so that they are made only for those who specially desire them, and are not one of the staple articles of their manufacture.

The branch establishment of the Auburn Manufacturing Company, for the sale of goods they make, is at 55 Beekman Street, New York city, where a large stock to supply the demand is constantly on hand, and which is well worth a visit, as a museum for the display of agricultural implements, by those interested.

The lands of the Auburn Manufacturing Company comprise thirteen acres, three of which are covered with the buildings necessary for carrying on their operations. Their water power is ample and never-failing, their capital is three hundred thousand dollars, and their situation gives them all the requisite railroad facilities for transportation. Their storehouse is a large three-story brick building, in which at times are stored vast quantities of their wares, in as great variety as can be found in any manufacturing establishment in the United States. Another building is their house for the storage of the wooden portion of their wares, with capacity for containing three hundred thousand handles at a time. These handles are kept on hand for several months before being used, in order to thoroughly season them.

The goods of the Auburn Manufacturing Company are distributed all over the country, going into all the states, east, west, north, and south, and also abroad to South America, New Zealand, Australia, and even to Europe. A portion of the rough material comes from England, and is returned to that country worked into various agricultural implements. The reputation of the wares made by the Auburn Manufacturing Company, which has led to their world-wide use, has been gained by the conscientious care exercised in their manufacture, and the scrupulous exactness with which every single article of their manufacture is inspected before it is allowed to go out into the market.

Their annual product of "hand tools" is the largest in the United States, and probably the greatest in variety and quantity of any factory in the world. At all the agricultural fairs, throughout the country, where specimens of their goods have been exhibited, the first premiums have been awarded them; and a more significant proof of their superiority in every respect is the fact, that intelligent and discriminating farmers and gardeners have, by "word and deed," invariably given the goods their unqualified approval.



LASTS.

THE NECESSITY FOR LASTS IN THE MODERN STYLE OF SHOE. — SANDALS. — THE PURPOSE SUBSERVED BY THE LAST. — THE DERIVATION OF THE TERM. — THE INTRODUCTION OF MACHINERY INTO LAST MAKING. — THE METHOD AND PROCESS OF MANUFACTURE. — THE LATHE FOR TURNING IRREGULAR FORMS. — HEELING, TOEING, AND IRONING. — SCOURING, POLISHING, AND FINISHING. — THE IMPORTANCE OF CORRECT MODELS. — MR. SAMUEL MAWHINNEY'S ESTABLISHMENT THE LARGEST IN THE UNITED STATES. — A DESCRIPTION OF IT. — THE EXTENT OF THE DEMAND FOR HIS WARES.

THE modern fashion of boots and shoes necessitates the making of lasts, as the form upon which the boot or shoe is modelled, and its shape given it. With the use of sandals among the nations of antiquity, the coverings of the feet were much simpler constructions than those now used. The material of the sandal, being of cloth or soft leather, required the use of a last to shape it on no more than the moccasins made by the Indians of this country required such an appliance. With the introduction, however, of the shoe, made of leather, with soles made of the same, the seams needed for uniting them together required that the material should be supported in place upon some substance sufficiently hard to allow its being easily sewed. Our lady readers who perform the good housewife's duty of darning the stockings of the good man and the children, will recognize from the small gourd, or other appliance, which is so convenient to place inside of the sock, the necessity of having a last to perform the same office in shoe making.

Our term *last* comes to us from the Anglo-Saxon *laest*, which was allied with the same word, meaning a track, or footstep, and from the original of which is derived the Icelandic word *lyste*, a shoe. They were at first, and have been until within quite a few years, made entirely by hand. In the various fashions for shoes which have arisen since their introduction, the lasts upon which

they were made have, of course, varied with them. The long, pointed shoes of the middle ages, like the similar but more moderate fashion which prevailed in this country a few years ago, were probably designed by some enthusiastic last maker who had an ideal of what the human foot should be, which he had evolved from the depths of his interior consciousness, without consulting the facts in his own or his neighbor's feet.

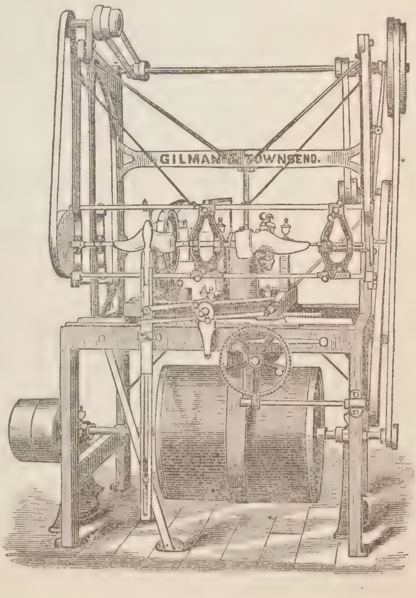
The style and fashion of the shoe depend chiefly upon the shape and form of the last, and the designer of this should have a knowledge of the anatomy of the foot, of the play of its various parts in walking, and of the necessary conditions to make a shoe at once a protection, a comfort, and an aid in using the feet. While lasts were made by hand entirely, each last in itself called for the display of these qualities in the maker, and the careful accuracy with which the model should be followed in working by hand, made only the most competent workmen fit for this work. When it is remembered by any one who has ever suffered the torture of wearing a boot or shoe which pinched in some spot, which did not fit, but seemed as though it was intended for some one else, that the fault lay with the defective character of the last upon which the shoe was made, the importance of the last maker will be fully recognized.

The application of machinery to the manufacture of lasts began with the invention of the lathe for turning irregular forms. The first machine of this kind was invented by Thomas Blanchard, a distinguished American inventor. Early in this century, being engaged in the Springfield armory, he invented a machine for turning gun barrels, and afterwards another for turning gun stocks. The idea of thus turning irregular forms was soon applied to the manufacture of lasts; and now they are all produced by machinery, with the greater advantage of securing the most perfect accuracy and uniformity.

Lasts are made of rock, or hard, maple wood. All other woods, except persimmon, are either too soft, or not sufficiently tough. Walnut would be tough enough, but not soft enough; black walnut too open in its grain; ash is not hard enough. The maple wood is chiefly furnished from New Hampshire. It comes into the market in blocks, prepared for this purpose, and averaging about twelve inches in length and five inches through both thicknesses. A cord will make on the average about five hundred pairs of lasts. Many hundred cords are yearly consumed in Massachu-

setts alone for making lasts. On a single machine, an average of four hundred pairs are made in a week, or seventy pairs in a day.

The wood is first seasoned, which requires at least two years, and is very important, since the value of a last depends in a great measure upon the correct seasoning. This process consists in piling up the blocks, under cover, and letting them dry there naturally. Any application of artificial heat, such as kiln-drying, would cause the wood to crack, and besides would destroy its life. When properly seasoned, the blocks are put into a machine for turning irregular forms. This machine is a complicated affair, which may be thus briefly described: A wheel about ten inches in diameter, and called a "cutter-knife," is arranged with four curved knives fixed on its periphery. This is hung on an axle, and supported by an iron frame, which also supports the other portions of the machinery. This cutter-knife is attached by its axle to a guide or model wheel. A swing frame is suspended before the wheels, into one portion of which, held by dogs, is fixed the block to be turned, in front of the cutter-wheel. On another portion of this swing frame is placed the "model," that is, a perfectly shaped last of the style into which it is intended to turn the block. This model is placed in front of the model wheel.



TURNING MACHINE FOR LASTS.

(The better to elucidate to the reader's understanding the turning machine for lasts, we introduce the accompanying engraving of a machine made by Gilman & Townsend, of Springfield, Vt., whose machines are used in the chief last manufactory of this country — that of Mr. Samuel Mawhinney — alluded to in the last pages of this article.)

The machine is then set in motion, when the block falls against

the cutter-knife, and the model against the model wheel. This wheel, running along the model, beginning at the toe of the same and passing slowly along to the heel, holds the block to be cut at just the proper relations to the cutter-knife, so that the block shall take the same shape as the model. The model and the block are respectively moved over the model wheel and cutter-knife simultaneously, by means of a regularly graduated "feeding" apparatus, which is a part of the machine, and which may be made to move as fast or slow as the work requires. On the machine various sizes of lasts, of the same general form as the model, but accurately reduced or increased in size, can be turned. A machine of this description costs about six hundred dollars.

The last being thus shaped out is taken to a jig-saw, where the "block" of the last, or the upper portion of a finished last, is rapidly cut out. The block is a necessary portion of the last, since it enables the shoemaker to remove the last from the boot. The three holes in the last are then cut, the two "hook" holes and the "jack" hole, which is needed only when shoes are made upon the last by machinery. The lasts are then heeled and toed by hand, that is, the "stubs" left on the last as it came from the machine are neatly trimmed off, and the toe and heel are shaped, the toes being made more or less square, round or long, according to the fashion of the times. Then a slight portion of the bottom of the last is cut out from the heel and toe, so as to "socket" them for receiving the "irons," which are thin pieces of flat iron for protecting the last from wearing, and for turning the points of the nails driven into the heels and toes of boots and shoes. This "socketing" is done on a revolving cutter.

When the ironing is done, a strap is sometimes put over the last, in order to prevent its splitting when used in a "pegging jack." The whole bottom of the last is sometimes covered also with an iron plate, when the last is to be used in nailing machines. The toe, heel, strap, and full plate irons are cut out by machinery from the sheets as they are brought from the rolling-mill. The best quality of English iron, the R. G., is used for these irons.

After the last is ironed, it is taken to the scouring wheels, and scoured and polished. These wheels are of wood, about thirteen inches in diameter, and three inches thick, and are covered on the edge with coarse drilling stuffed with flannel, to keep them from getting on fire by the friction caused by pressing the lasts against the wheel. The drilling is then covered with a coating of warm

glue, upon which is then sifted a flour made of pulverized quartz, which is mostly obtained in the Green Mountains, and is ground up in mills. A barrel of this pulverized quartz brings in market about ten dollars.

When polished, the lasts are washed in a liquid preparation, the basis of which is linseed oil, and which serves to preserve the last, and make it easier to pull it out from the shoe, besides giving it a more finished appearance. The lasts are packed for market in bags, about twenty pairs filling a bag.

The great skill in last making lies in the modelling, which is properly the first process, as all lasts are made after a model. Very few artists are competent to make a good model. The nicest sense of form, an accurate knowledge of the anatomy of the foot,

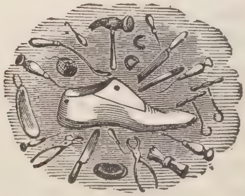
LAST MANUFACTORY, WORCESTER, MASS.

and good judgment about the bearing of the shoe upon the parts of the foot, when made upon a given general shape of the last, is necessary in the modeller. Perhaps, however, the greatest task of the modeller is to suit the caprices of fashion, and the fancies of the different manufacturers, while adapting the last at the same time to the foot. There is a constant tendency to change in the shape of the shoe, and consequently of the last. The variations in the shape are innumerable, changes taking place daily. In fact, the last maker has much to do with the fashion of the shoe. In New England anything which is extreme is generally here, as elsewhere, fashionable.

The leading manufacturer of lasts in the United States is Mr.

Samuel Mawhinney, whose establishment is in Worcester, Mass. He learned his trade in Boston, and has been engaged in the business some twenty-eight years. Mr. Mawhinney's establishment is the largest in the country, and was built by him specially for carrying on his business, which is divided into different departments, and provided with the best machinery, and every appliance for securing the best results in his specialty. The facilities of the establishment enable Mr. Mawhinney to respond at once to any order made upon him in this line of manufacture without delay, and with the certainty of furnishing perfect work. In the business of last making two things specially conspire for success — the utmost perseverance and conscientious dealing. It is impossible to win such a reputation as Mr. Mawhinney has secured without exercising the most scrupulous care that not a single last shall leave his hands without being subjected to the closest scrutiny of inspection, and pronounced perfect. The wood used must be properly seasoned, and the work skilfully done, else the last will be found imperfect in the customer's hands, either sooner or later.

Mr. Mawhinney's lasts are in demand throughout the New England and Western States, as well as largely in the South. An average of four hundred models are made in his establishment annually, at a large cost, and for which there is no direct return, but has to be considered as so much capital sunk.



GUNPOWDER.

HISTORIC SPECULATIONS. — GREEK FIRE. — BY WHOM WAS GUNPOWDER INVENTED? — SCHWARTZ. — BACON. — COMPOSITION OF GUNPOWDER. — PROCESS OF MANUFACTURE. — HOW POWDER IS TESTED. — EARLY HISTORY OF POWDER MAKING IN THIS COUNTRY. — PRESENT CONDITION OF THE BUSINESS.

It is generally supposed that the Chinese had some knowledge of gunpowder at a very early period, some say two hundred years or more before the Christian era. It is inferred from statements in ancient histories that the Hindoos had discovered some explosive substance which they used to defend themselves against their enemies. In an account relating to the expedition of Alexander the Great into India, it is thought he avoided certain places or peoples because of their use of this strange fire — "for they come not out to fight those who attack them; but those holy men, beloved of the gods, overthrow their enemies with tempests and thunderbolts shot from their walls." Others observe that the knowledge of gunpowder appears to be coeval with the most distant historic events relating to China and India. In China it has for ages been applied to useful purposes, as blasting rocks, etc., and in the manufacture of fire-works; although it has not in earlier times been directed through strong metallic tubes for the propulsion of solid bodies, as the Europeans used it soon after its discovery. It is thought that the Arabs, by their intercourse with China or India, became acquainted with this material, and that they communicated their knowledge of it to the Greeks. It is thought by some that with this knowledge originated the celebrated *Greek fire*, which enabled those who possessed the secret of its composition to gain so many victories. Whatever may have been its composition, Constantinople was twice delivered from its besieging enemies by the novelty, the terrors, and the real efficacy

of the Greek fire. The skill of a chemist and engineer was equivalent to the succor of fleets and armies. It was employed with equal effect on sea and on land, in battles and sieges. It was poured from the ramparts, or launched in red-hot balls of stone and iron, or darted on arrows and javelins; sometimes it was deposited in fire-ships; and was most commonly blown through tubes of copper, which were planted on the prow of a galley, and fancifully shaped into the mouths of savage monsters, which seemed to vomit a stream of liquid and consuming fire. A knight, who despised the sword and lances of the enemy, relates with heartfelt sincerity his own and his companions' fear at the sight and sound of the mischievous engine that discharged a torrent of the Greek fire. It came flying through the air like a winged long-tailed dragon, with the report of thunder and the velocity of lightning, and the darkness of the night was dispelled by this deadly illumination. The use of Greek fire by those who knew the secret of its composition continued till the middle of the fourteenth century, when scientific experiments brought to light the use of that compound of nitre, sulphur, and charcoal, which accomplished a new revolution in the art of war, and in the history of mankind.

The precise date of the knowledge and use of gunpowder in Europe it is not easy to determine, though some time between the ninth and twelfth century is assigned to its introduction. The crusaders, in their conflicts in the East, were sometimes terrified by the fiery weapons and engines employed to repel their attacks; and to their experience and knowledge acquired in those wars for the recovery of Jerusalem may be due the earliest introduction of some form of gunpowder into Europe. The Germans claim that a Franciscan friar, Berthold Schwartz, who lived at Mayence in the early part of the fourteenth century, was the inventor of gunpowder. Others give the credit of this invention to Roger Bacon, who died in the latter part of the thirteenth century. In the recipe given by Bacon, he conceals one of the ingredients under the form of an anagram, which being transformed may read as follows: "But, nevertheless, take of saltpetre, with powdered charcoal and sulphur, and thus you will make thunder and lightning, if you know the mode of preparing it." It is altogether probable that the imperfect mode of mixing the component parts, adopted by the Chinese, the Arabs, and the Greeks, gave them a compound whose particular quality was a sudden and sparkling combustion, while later chemical experiments of Bacon and Schwartz

made a more perfect combination, which is substantially that of the present time. Different nations, apparently without communication with each other, have long been in the habit of using very nearly the best proportions of the three ingredients, viz.: in the manufacture of every one hundred pounds of gunpowder there are seventy-seven and one half pounds of saltpetre; sulphur, ten and one half pounds; charcoal, sixteen pounds; which together equal one hundred and four pounds, the extra four pounds being allowed for waste. For blasting purposes, a cheaper and more efficient powder is preferred, of which saltpetre forms sixty-five, sulphur twenty, and charcoal fifteen per cent. Powder of this combination is not so quick in its explosion as the other kinds, but it is more efficient for the service to which it is applied. This powder also is made of very coarse grain, in order to increase the time in exploding.

The ingredients in the composition of gunpowder should be of the greatest attainable purity. Saltpetre, as it is usually found, is unfit for immediate use, being united with impurities which prevent the close contact and combination of the other ingredients. It is refined by solution in an equal weight of spring or river water, which is raised to a boiling heat; the solution is then strained, and crystallized in copper pans. It is then refined a second time, in a similar manner, after which the water is expelled by fusion, and the nitre assumes a delicate, white appearance. The sulphur is refined by fusing in gun-metal pots, and skimming off the impurities. The quality and value of gunpowder are very seriously affected by the quality of the charcoal used in its manufacture. The kind of wood employed, and the mode of preparing the charcoal, will vary the character of the powder. Woods which give a hard, flinty coal are objectionable; the coal should rather be soft, free from any extraneous particles, so as not to scratch polished metal, and give out no smoke when burning. Whatever woods are employed, they are first stripped of their bark, and instead of being burned in coal pits, they are prepared in iron cylinders.

The kinds of wood generally used are black alder, black dog-wood, and willow. In France, the alder is exclusively used, the smaller branches being preferred. In England, black dog-wood is used for the manufacture of sporting powder, while the government establishments use only alder and willow. In the vicinity of powder mills in the United States the willow is largely cultivated; it is of rapid growth, and by frequent cutting, the shoots are

kept down to a small size. These woods are reduced to coal in iron cylinders heated to redness. It is said to be best when newly prepared from seasoned wood; it should be perfectly charred, and should present the same appearance throughout — either dead black or shining, according to the kind of wood. The most inflammable powder is made with charcoal, prepared at a moderate heat, not exceeding 500°. That which has been subjected to a higher temperature in its preparation, makes a kind of powder which burns slower, and is better adapted for blasting and for artillery than for the rifle.

When the several ingredients are prepared, they are separately reduced to an impalpable powder; they are then mixed together in the proportion before named, in a barrel or cylinder arranged for the purpose. The composition is then sent to the powder mill in charges of from forty to fifty pounds each. This mill is generally in a small building, standing by itself on account of the danger of explosion. The mill is made of two rollers of three or more tons' weight, which revolve round a vertical shaft on beds of the same material as the rollers, the beds being surrounded with wooden sides, like sides of a tub. The bed and rollers are sometimes made of cast iron, and sometimes of compact limestone or marble. The circular bed in which the rollers travel is about seven feet in diameter, and they are not allowed to revolve more than eight times in a minute. Each charge of forty or fifty pounds, placed under the rollers, is moistened with from two to three pints of water, and the process of incorporating or thoroughly mixing the elements occupies about three and a half hours. The complete incorporation of the ingredients is very essential to the making of good gunpowder; and much experience is necessary to direct the operation, and to determine the fitness of the mixture for the next part of the process. It cakes together in hard lumps, and is called *mill-cake;* it is then subjected to a heavy pressure between copper plates, so that when taken out it is in the form of large, solid cakes, half an inch in thickness, and is called *press-cake.* The powder is then reduced to grains, by a process called *granulating.* The *press-cake* is crushed between toothed rollers, or broken by wooden mallets into small pieces; it is then put into parchment sieves, pierced with holes of the size required for the particular kind of gunpowder which is in process of manufacture. The sieves are placed in a frame, which is shaken by machinery with a backward and forward motion; each sieve contains two flat circu-

lar pieces of lignum-vitæ, about two inches thick, and six inches in diameter, which, by the motion given to the frame, rub and grind the powder until small enough to pass through the holes. It is then received into hair-cloth sieves, by which the grained powder is separated from the dust. The next step in the process is called *glazing*, which is accomplished by placing the gunpowder in a canvas cylinder, or large cask, which is made to revolve forty times each minute, and by the rubbing of the grains against each other, the angular points are broken off, and the grains acquire roundness, as well as smoothness and polish of surface. This latter quality, or appearance, is sometimes fraudulently imparted by putting into the glazing barrel a small quantity of powdered black-lead. Pressing and glazing are of great importance in the manufacture of gunpowder, since by pressing an equal degree of density is given to the grains, and by glazing, the powder is less liable to absorb moisture, or produce dust by the shaking and friction caused by transportation. After glazing, the gunpowder is thoroughly dried at a temperature of 150° ; this is done by raising the temperature of the drying-room by means of currents of hot air, or by steam pipes.

The quality of gunpowder may be tested by its not being easily crushed in the fingers, nor readily soiling them ; also by placing two small parcels on clean white paper, three or four inches apart ; then fire one of these parcels ; if the paper is free from white specks, and not burned into holes, and if no sparks flying from it ignite the other contiguous parcel, the powder is very good ; if these tests fail, the ingredients are badly mixed or impure. The strength of gunpowder is tested by an *éprouvette,* which is a small, strong barrel, in which a given amount of powder is fired, and its projectile force is measured by the action exerted on a spring or a great weight. Count Rumford confined twenty-eight grains of gunpowder in a cylindrical space, which it just filled, and upon being fired it tore asunder a piece of iron which would have resisted a strain of four hundred thousand pounds. A mortar was loaded with one twentieth of an ounce of powder, and upon it was placed a 24-pound cannon, weighing over eight thousand pounds ; when the charge was fired, the mortar burst with a tremendous explosion, and lifted up the enormous weight.

The earliest reference to the manufacture of gunpowder in this country appears in an order of the General Court of Massachusetts in 1639. A grant of five hundred acres of land was made

to Edward Rawson if he should continue the making of powder. In the year 1666, Henry Russell and others, having made preparations for saltpetre and powder works, were granted certain privileges by way of encouragement. A powder mill was built at Dorchester previous to the year 1680. The numerous French and Indian wars, and the nature of colonial life and trade, created a great demand in England for gunpowder for America.

In the year 1774, just previous to the revolutionary war, the exportation of powder and its materials was prohibited by an order in council. The Continental Congress, the several State Conventions, Assemblies, and Committees of Safety, used all means to encourage the manufacture of powder. The Provincial Congress of Massachusetts, in December, 1774, stated in a resolution that the ruins of several powder mills existed there, and many persons understood the business of making it. It recommended the restoration of one or more of the mills, or the erection of others. In the following year, a powder mill was built in East Hartford, Conn., by William and George Pitkin, under an act of the Assembly regulating their erection, and giving a bounty of thirty pounds each for the first two powder mills erected, and ten pounds for every hundred weight of saltpetre made during the next year. About the same time, a powder mill was erected at much expense at South Andover, Mass., by Hon. Samuel Phillips, founder of Phillips Academy. This mill, and another at Stoughton, supplied the army with large quantities of powder. In 1775, large saltpetre works were established in Philadelphia, in Boston, and other places. Congress authorized the publication of a manual, giving several methods of making saltpetre. The Council of Safety caused the erection of several saltpetre and gunpowder factories in Pennsylvania.

A powder mill was built early in the war at Morristown, N. J., and being amply supplied with saltpetre by the inhabitants, afforded considerable supplies when they were greatly needed. The State of New York offered premiums for the erection of mills capable of producing one thousand pounds a week. The authorities of Maryland granted one thousand pounds for the erection of saltpetre works, and a like sum was voted for a provincial powder mill, in the year 1775. The States of Virginia, North and South Carolina, and Georgia also passed laws encouraging the manufacture of gunpowder and the ingredients for making it.

These efforts, put forth under the influence of a great necessity,

resulted in permanent establishments for the manufacture of gunpowder in several states. In the year 1790 there were twenty-one powder mills in Pennsylvania, producing annually six hundred and twenty-five tons of gunpowder. In 1793 the magazine in Philadelphia contained fifty thousand quarter casks of gunpowder manufactured in that state. During the continuance of the war, however, the supply from home production was inadequate to the necessities and demands of the government. The deficiencies were met in part by supplies from the West Indies and elsewhere, and a considerable amount was fortunately obtained by capture.

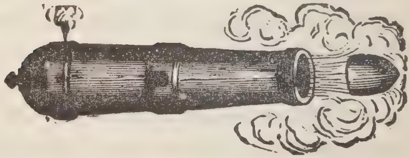
In the early part of this century gunpowder was extensively manufactured in Delaware by Dupont de Nemours. His powder, in packages impressed with the figure of an eagle, was celebrated for its good quality. Wilson, the American ornithologist, says it left no stain on paper when burned.

> "From foaming Brandywine's rough shores it came,
> To sportsmen dear its merits and its name;
> Dupont's best Eagle, matchless for its power,
> Strong, swift, and fatal as the bird it bore."

In the year 1810 the manufacture of gunpowder was nearly, and could at any time have been made, equal to the demand for home consumption. The establishment of Dupont de Nemours, in Delaware, had a capital of seventy-five thousand dollars, and employed thirty-six men; it was capable of producing six hundred thousand pounds annually, and was regarded as the most perfect in operation. There were two mills in Baltimore, with a capital of one hundred thousand dollars, which produced annually four hundred and fifty thousand pounds, of excellent quality. In the year which followed, large establishments were put in operation in Virginia, New York, Massachusetts, and Connecticut. The Hazard Powder Company have very extensive gunpowder mills near Hartford, and at Canton. This company have eighteen sets of rolling mills, seven granulating mills, five screw-press buildings, and three hydraulic presses of five hundred tons each, in different and separate buildings. They have also about fifty buildings employed for mixing, drying, glazing, dusting, assorting, and packing, with saltpetre refineries, machine shops, and magazines, — in all, about one hundred and twenty-five buildings, — at Hazardville. The propelling power of this machinery consists of twenty-five water-wheels and three steam engines. The value of the annual product

of this company exceeds one million of dollars. During the Crimean war, they supplied the British government with ten thousand barrels of powder, which was pronounced by officers of the army to be of superior quality.

The discovery of gunpowder, doubtless accidentally made, prepared the way for great changes in the whole system of warfare, both offensive and defensive. As an instrument or means of human destruction, it far surpassed any before known or devised by the skill of man. With every improvement in fire-arms, its importance appeared to increase. Whether its use has rendered wars less frequent or less sanguinary may be difficult questions to decide. The recent improvements in artillery, in rifles, and all fire-arms, will tend, other things being equal, to render pitched battles short, sharp, and decisive. If the destructive character of the weapons used in war should be further increased, wars for small causes would not often occur, and, as a costly luxury, would probably be dispensed with altogether. But gunpowder will continue to offer an available store of mechanical force to the miner and the engineer; the sportsman and the maker of fire-works will still find it a means of usefulness and pleasure.



THE EXPRESS BUSINESS.

THE IMPORTANCE OF THE EXPRESS BUSINESS. — A BEE-HIVE COMPARED TO AN OYSTER-BED. — WILLIAM F. HARNDEN THE FIRST EXPRESS MESSENGER. — HIS FIRST TRIP FROM BOSTON TO NEW YORK. — THE ADAMS EXPRESS. — OTHER LINES. — THE WESTERN LINES. — THE ADAMS EXPRESS COMPANY. — THE CAPITAL IN THE EXPRESS BUSINESS. — THE EXTENSION OF THE BUSINESS. — THE "C. O. D." PLAN. — MONEY COLLECTION. — ITS INFLUENCE ON EXCHANGE. — THE SYSTEM PURSUED IN THE BUSINESS. — THE EXPRESS DURING THE LATE CIVIL WAR. — ITS AID TO THE SANITARY COMMISSION. — THE TENDENCY OF MONOPOLIES TO COMBINE. — INSTANCES FROM OTHER IMPROVED SOCIAL METHODS. — THE POST-OFFICE AS A BASIS FOR THE EXPRESS. — CONSIDERATIONS FOR AND AGAINST THIS CHANGE.

One of the most important advances of our modern civilization is the establishment of the express business, while the rapidity with which it has attained its present development shows the increased activity of the social forces of to-day compared with those in the world less than two generations ago. The activity and circulation of our modern life compare with that of the last century somewhat as the busy movement of a bee-hive, where each member is actively at work with his allotted task, coming and going in search of the material he needs for adding to the stores of the community, compares with an oyster-bed, where, rooted to the soil, unable to move about in search of what they need, the bivalves wait with open shells, trusting that at the rising tide fortune may bring them the food they want. In the one there are concert of action, mutual interdependence, and mutual assistance; in the other a monotony of sluggishness, and isolation instead of union.

It is almost impossible to realize at present how the generation before ours managed to do without expresses. The difficulty in the way of promptly and easily circulating small packages was, of course, an insuperable obstacle in the way of much of the activity

of our present commercial and social relations; and as a necessary adjunct to the railroad and the steamboat the express came into existence. Yet it is singular that the steamboat and the railroad had been so long in operation before the idea of the express originated.

In 1839 William F. Harnden, of Boston, at the suggestion of some of his friends, advertised in the papers that he would make regular trips, as a messenger, between Boston and New York, by the Providence Railroad, and the steamboat from thence to New York, and would take personal charge of such small packages or orders as should be intrusted to him. In accordance with this announcement, he made his first trip on the 4th day of March, having in charge a few booksellers' parcels of books, some orders, and packages from the brokers of southern and western bank notes, to exchange or deliver. Mr. Harnden designed also to attend to freight, and see that it was promptly delivered. For this purpose he had made a contract with the railroad and steamboat companies, and had intended to make four trips a week.

With a shrewd comprehension of the elements of success, Mr. Harnden made himself of great use to the press, bringing them matter in advance of the mails, and thus securing their cordial coöperation in the success of his enterprise. The convenience and advantage of the undertaking were, however, promptly recognized by the mercantile community of the two cities, and the increase of the business speedily caused its more thorough organization. This was, however, the commencement of the Harnden's Express, and the beginning of the extension of the business, until it has finally encircled the world, and has its representatives in every town and village throughout the country.

In 1848 Mr. Harnden himself died, without having acquired more than a very moderate reward from his connection with the business, but not before he had seen it become one of the financial and commercial giants of the land. The year after the commencement by Mr. Harnden, in 1840, a competing express was started, to connect Boston and New York by the Norwich and Worcester line. This enterprise was undertaken by P. B. Burke and Alvan Adams, though the sole ownership and management of it soon passed entirely into the hands of Mr. Adams.

In the beginning, a carpet-bag was thought sufficient for the accommodation of this business, from which has grown the Adams Express Company, with its widely extended business connections,

its immense capital, its army of assistants, its troops of horses, and its trains of cars.

In 1840 D. Brigham, Jr., Mr. Harnden's New York agent, became a partner in the business, and going soon after to England, established the foreign branch of the Harnden's Express, and introduced the idea of the express business in Europe.

In 1841 Mr. Adams associated William B. Dinsmore with himself as a partner, giving him the management of the New York end of the line. On the return from England of Mr. D. Brigham, Jr., Harnden's Express was extended, in 1841, to Philadelphia and to Albany. A year or two afterwards Adams & Co. took Mr. E. S. Sanford into the concern as a partner, and gave him the charge of the agency of their business in Philadelphia, which was brought into their line at this time. Mr. Sanford, with S. M. Shoemaker, of Baltimore, also about this time established an express from Philadelphia to Washington. About the same date a third express from Boston to New York, by the Newport and Fall River line, was established by Gay & Co. From Albany to Buffalo, and thence to the other cities of the West, the express lines were established by Henry Wells. Under the name of Wells & Co. the first express west of Buffalo was established in 1845. This and other western expresses were finally consolidated in the American Express Company.

In 1849 Adams & Co. extended their express line to California, and in 1852 Wells, Fargo & Co. established theirs. In 1854 Adams & Co., Harnden's Express, then owned by Thompson & Livingston, Kingsley & Co., and Hoey & Co. were consolidated in the Adams Express Company. The stock of this company is divided into twelve thousand shares, having no regularly stated par value, but estimated at one hundred dollars each, thus making a capital of one million two hundred thousand dollars. The estimated aggregate of the capitals of the various leading express companies is placed as high as twenty or thirty millions of dollars, while, together with the various local expresses, each town of any size having its representatives, their ramifications extend all over the country. Depending chiefly upon the great railroad lines, which transport the bulk of the staple productions of the country, they yet branch off upon every connecting road, and also almost every stage line, thus placing almost every hamlet in the country in possible and easy connection with all the great centres.

The social activity which such a condition of things generates,

and to which it ministers, being at once a cause and effect, can hardly be overestimated. Though its results are not yet wholly developed, yet it serves at least as the basis for a physical organization of society, in which the circulation shall be as perfect as that of the blood in the body.

Besides the transmission of packages, the various expresses have become most valuable auxiliaries to the financial organization of commerce, and to the banking interests of the country. They not only deliver goods, collecting the bills for them, and returning the money to the seller, — a system which has grown into most general use, and is known technically as sending goods "C. O. D.," that is, "collecting on delivery," — but it has also been estimated that the value of the bank notes and other moneys daily transported by them amounts to fifteen or twenty millions of dollars. With the various banks, bankers, and brokers they have contracts for performing this service, charging for it at the rate of about twenty cents a thousand dollars, varying slightly with regard to the distance; and in this way their charge has come to be in a great measure the regulator of the rate of exchange between the various money centres of the country, and has very greatly reduced the average which formerly prevailed, and thus been productive of a great saving to the producers and consumers of the country.

The expresses travel generally on the fastest trains, and have frequently their own cars devoted entirely to their business. Each of the trains is accompanied with a special messenger, who has the business under his personal supervision. The valuable packages are enclosed in large iron-bound trunks, and the money in safes. The position of messenger is a very responsible one, and by no means devoid of danger, as has been recently shown in several instances, where daring thieves, knowing that valuable booty was in their care, have planned to introduce themselves into the car while in motion, and overpowering the messenger, rob the safe. By such robberies the lives of several messengers have recently been lost, since the desperate thieves engaged in these enterprises stop at nothing to carry out their designs.

The business of the various expresses, notwithstanding it is so large and so complex, is so well organized and arranged that both great simplicity and accuracy are secured in its working. Every package is entered on the way bill, and the messenger in charge of the shipments on the train delivers to the express agents at the various stations the goods intended for them, and receives any

articles left with him for further shipment. This is generally done during the time when the train stops for the accommodation of passengers, promptness and despatch being made synonymous with express. Everything intrusted to the express for transportation is entered, with the date, upon the way bill at the office or station at which it was received. The address in full is marked upon each package, and the charge which is to be collected upon its delivery. If the charge is prepaid in whole or in part, the package is so marked, and if it has been received from some other express, or any source which had a claim upon it for previous charges, these are paid, and the amount entered in a cash column, and collected with the freight upon its delivery. If the freight and charges have, however, been prepaid, an entry of this kind is made; and also if there is a credit for forwarding the package beyond the end of the express route, this is also entered in its appropriate column.

The amounts of the "prepaid" and "paid through" columns are charged to the agencies at which the packages are received, and those of the freight and express columns to the agencies to which the way bills are sent. Thus the accounts are kept correct, and the material prepared for tracing out any error which may occur. As the way bills are always kept in duplicate in the offices from which they are issued, the ability of tracing all errors is assured. The simplicity with which such a varied and extended business is kept, and the promptness with which, though it is so new, and had no precedents from which to borrow, it has been organized, speak well for the business ability of the Americans, and the ease which they display in adapting themselves to new conditions.

Perhaps one of the most striking evidences of this was afforded during the late civil war, by the aid rendered the army by the express. It was to be expected that, when the army was raised in a year from an average of about twenty thousand men to nearly a million, difficulties would have been experienced in keeping its transportation commensurate with such increasing needs; and though it was a cause of surprise and congratulation that this arm of the service was so efficiently administered during the contest, yet in many cases of emergency the express companies rendered an aid in the saving of stores which was worth millions to the nation. In the distribution of the mail to the army, and transporting the pay, which frequently required cart-loads of greenbacks, their business organization rendered them very efficient, and they earned a debt of gratitude from every one who profited

by their services. Without their aid, also, much of the needed work of the Sanitary Commission would have been left unperformed, and the comforts, the delicacies, and the various offerings to those in the field, by which those anxiously interested at home sought to express their sympathy and love, would never have reached their destination, or would never have been sent.

While the express business, however, has shown itself by its sudden growth to be an absolutely necessary organization for satisfying and encouraging the activity of modern society, and though it has admirably satisfied the needs which called it into being, yet, as with almost every new method introduced into our social organization, the public needs require that further changes should be made in order to meet the necessities which have been created by the measures themselves. It is with the express as with the post office and with the railroads.

When the postal system was first established it was a great public convenience, and while it satisfied the necessity of intercommunication between the different parts of the country, it also stimulated the social and industrial activity of the people, and the charge for carrying letters, which at first seemed light compared with the advantage of having the opportunity of sending a letter by a certain, constant, and trustworthy post, without having to depend upon special messengers, or the personal kindness of acquaintances who happened to be going that way, came to be onerous, and the reform of cheap postage is one of the surest indications of the advance in civilization.

With the railroads in this country, which have really become the necessary means of traffic and travel, replacing the old roads used for these purposes, the system pursued was to trust to competition for cheapening the charges; but our experience has shown how weak and mistaken was the confidence felt that in this way the public would obtain the best advantages from this new method of transportation.

Not only has this country given evidence of this, but in Europe also, where the opportunity is offered for comparing the two systems, the one in which the railroads are considered as public conveniences, like the mint or the post office, and controlled by the government, and the other in which the public convenience has been trusted to the uncontrolled effects of competition, the advantages of the first method are made more apparent.

In England the railroads were left to private enterprise, and the

result has been that, as a general thing, they are all bankrupt, and Parliament has been forced to seriously consider the necessity of placing them all under governmental control. On the continent, however, in France, Austria, Prussia, and Belgium, the railroads were built under limited charters, to revert to the government in a certain time, while their rates of charge are meanwhile under the inspection and control of the government, or else they have been built and are operated by the government. In no instance have they been left, as here or in England, entirely to private enterprise, while the public are left dependent upon their liberality or intelligence for affording the necessary transportation, and at the cheapest rates.

In Belgium the governmental system is the most perfect. The roads have been built and are operated, with the telegraphs, by the government; and its constant aim has been to increase the commercial activity of the people by constantly cheapening the cost of transportation. The statistics of the country show most conclusively the advantage of this system, and Belgium has the cheapest and best managed railways in Europe. Any profit made by operating them helps to pay the taxes, or is considered a proof that the rates should be reduced.

In England, however, the competitive system has made the railways bankrupt, and spread the widest disaster among the stockholders. It has been shown, then, that the irresponsible financial control of such an important industrial aid as the railroad has become in modern society should not be trusted in private hands, while in this country our experience has gone a great way towards demonstrating the same truth. It is difficult for any one to say what is really the value of the stock of many of our chief roads, upon which the industrial activity of large sections of the country is absolutely dependent.

In the United States, however, the system of intrusting the railroad to private enterprise has developed a new feature, which is shown equally with the express. In such gigantic enterprises, which require for their successful operation large capitals, the public cannot depend upon the action of competition to obtain the requisite cheapness. It is impossible that there can be any competition, since the community has neither the money, the time, nor the inclination to establish one; and further, as was seen in the contest concerning the establishment of river navigation by steam in this country, and as is at present shown both in the manage-

ment of the railroads and the expresses, the established lines are much more able and prompt to combine against the public in the maintenance of their monopoly than the public is to combine in the establishment of a competing line. The great expresses of the country have displayed this tendency, and their action has been far from proving an advantage to the general interest of the public.

With the increasing complexity of civilization we are beginning to see that all monopolies are unscientific and uneconomical, and that the interest of the entire public is best subserved by not intrusting to irresponsible parties the performance of the work needed for the general welfare.

In the post office we have already the framework of an express system, which could be easily enlarged sufficiently to perform the express business of the country needed by the increasing activity of our social and industrial life, much more economically than it is now done. The extra expense necessary to so enlarge the operations of the post office as to embrace the express business of the country would be a much smaller charge upon the industry of the country than that levied by the express, as at present organized.

That government work is poorly and expensively done is generally made an objection to any suggestion for enlarging its sphere. But this is not so, as the mint and the post office show. And besides, were this so, the fault would not be in the principle, but in the defective organization by which such work was performed; and the remedy lies clearly in the hands of those from whom the government gets its power, and to whom it is responsible as a servant.

With every year's experience, the social importance of the material question is becoming more and more apparent, and the necessity for improved methods of organization to satisfy the changing conditions introduced by the new spirit of the time, which is daily manifesting the necessities for a closer union and interdependence of the various peoples of the earth, must in the immediate future attract the attention of our statesmen, and their solution, rather than those of the petty disputes of party, be the object of their labors. With the study of the course of social advance, and a method by which to pursue such investigations, the solution of these questions will be made upon the universal plane, instead of upon that of parties or of rings; and among them hardly one is more important than that of the express business.

FANCY LOOM MAKING.

THE INVENTION OF THE LOOM. — LOOMS AMONG THE NATIONS OF ANTIQUITY. — FANCY LOOMS. — MR. WILLIAM CROMPTON. — HIS FANCY LOOM. — ITS FIRST PRACTICAL APPLICATION. — THE PROFITS FROM ITS USE. — MR. CROMPTON'S OTHER INVENTIONS. — MR. GEORGE CROMPTON. — THE CAPACITY OF THE CROMPTON LOOM WORKS. — IMPROVEMENTS IN "FANCY LOOMS." — THE CONSTRUCTION OF A FANCY LOOM. — THE PROCESS OF MANUFACTURE. — THE VARIOUS DEPARTMENTS IN THE CROMPTON LOOM WORKS.

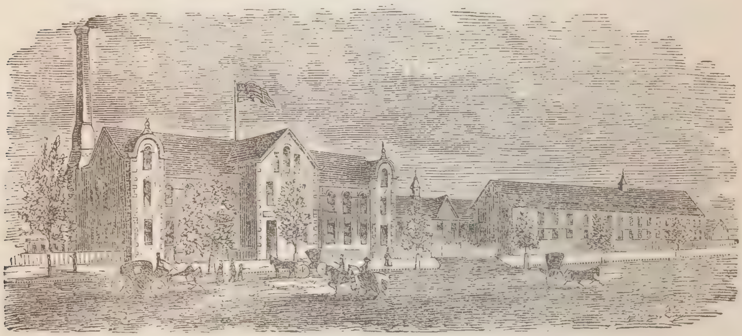
THE invention of a loom, or an instrument by which a continuous fabric is woven from threads, dates back to the pre-historic period of history, and was probably one of the first inventions made by mankind. On the tombs at Thebes, and upon other remains of Egyptian architecture, looms of a simple construction are still to be seen pictorially represented, and the cloths which have been found upon the mummies taken from the Egyptian tombs show, from the fineness and regularity of their texture, that the Egyptians had the art of doing better weaving than it would be supposed possible from the apparently imperfect character of the looms there represented.

In India, also, the use of the loom has been known from the earliest times, as it was also in Greece. Some of the fabrics from the looms of India are unrivalled even now for their delicacy of texture; and Homer speaks of a figured web, in which were the figures of a Gorgon and dragons, woven in the texture. It is beyond question that the diapered and figured textures made by the natives of India and the Greeks were excellent, notwithstanding that their looms were of a very rude description; but their industry, in this department, as in others, was not so inexorably bound as that of the modern world is, by considerations of money and time. Now, with the greater activity of our industrial occupations, the products of our fancy looms are not limited for their consumption to the few, but the increased demand has necessitated

such an increased production, that improvements in the looms have become a necessity.

The use of the loom in Europe was introduced in the early years of the Christian era, and Italy and the Netherlands were, for a time, the countries most distinguished for their skill in its use. The precise date of its introduction into England is not known, but about the period of Queen Elizabeth's reign the English began to attain the perfection for which they have so long been distinguished.

The term "fancy loom" is used to designate such looms as produce figures in the weaving. In the manufacture of fancy looms, the leading establishment of this country is the Crompton Loom Works, situated at Worcester, Mass. This house has an historic reputation for the production of its specialty, which, under



CROMPTON LOOM WORKS, WORCESTER, MASS.

the management of its present proprietor, Mr. George Crompton, it is destined to maintain and increase.

In 1836, William Crompton, a native of England, came over to this country. He was at this time about thirty years of age, and was an accomplished weaver and mechanic. With his practical knowledge of weaving and the necessities of the loom, together with his mechanical ability, he was enabled to invent a fancy loom, which supplied the want then seriously felt for this desideratum in the business of weaving. The looms then in use in England were the Dobby and Wizard and Witch looms, and both of these needed improvements. The Dobby loom only lifted the warp without depressing it, and the result of this imperfect mechanism was, that the threads of the warp were badly strained.

Mr. Crompton's invention to remedy this fault was of a very simple and ingenious character, and he obtained a patent for it, in the United States in 1837, and in England in 1838, under the name of John Rostron, his English partner. Having carried his loom to England in this year, it was there received with great favor. On his return to this country, in 1840, his attention was arrested by the fact that at that time the woollen goods made in the United States were manufactured on twilled looms. Calling upon Mr. Samuel Lawrence, the agent of the Middlesex Mills, this gentleman gave him an order to change the looms of the mill from plain to fancy ones. In six months the change was completed, and the company engaged in the making of fancy overcoatings, which was the first practical application of the Crompton loom.

From the profits made by these mills by the use of these looms, between the years 1840 and 1848, the company built another immense mill, which may be said to have been the foundation of the present city of Lawrence. The favor with which the Crompton loom was there regarded gave it a great reputation in other quarters. Soon after the Middlesex mills had got into operation with the Crompton looms, Mr. Crompton, being without ample means, sold to Messrs. Phelps and Bickford the exclusive right to manufacture them, for a royalty. This firm engaged in making these looms, adding to them the occasional improvements made by Mr. Crompton, while he himself was engaged in travelling, setting up the machines, and instructing the operatives in their use, and how to design patterns for the cloth to be woven by them. Many influential mill owners of to-day will remember the instructions they received from Mr. Crompton, the inventor.

Mr. William Crompton was also the inventor of various other machines than these looms which bear his name, and throughout his life has displayed a very rare faculty for mechanical combination and original invention. While the making of these looms proved lucrative to their builders, the royalty paid the inventor was so small that, up to 1851, at the expiration of the patent, Mr. Crompton had received only about fifteen thousand dollars. Meanwhile he had engaged in the manufacture of textile fabrics, which had proved unprofitable.

In 1849 Mr. Crompton became very ill, and up to this time has never fully recovered his health. In consequence of this illness, he retired from active business. In 1851 Mr. George Crompton, his son, having become of age, obtained an extension of the pat-

ent, and taking a partner, went into the business of manufacturing fancy looms in Worcester, Mass., including the improvements made by his father, and improvements of his own invention. In 1859 the firm was dissolved by the retirement of his partner, and Mr. Crompton, having erected his present works upon the site of the old establishment, has continued the business individually since. During the continuance of the partnership, Mr. Crompton found that his father's inventions were pirated by some leading loom manufacturers. Invoking the aid of the law to protect his rights, he, after considerable litigation, which drew heavily upon the funds of the copartnership, succeeded in maintaining the validity of the elder Mr. Crompton's patents, as well as of his own.

On the breaking out of the war of 1861, the loom business being limited, Mr. Crompton devoted a part of his establishment for a time to the manufacture of gun-making machinery for the United States and various large private armories. Finally, in 1863–4, the demand for blankets, etc., for the soldiers, being so great, Mr. Crompton resumed the building of fancy and plain looms for weaving woollens, extended the capacity of his works to the number of four hundred hands, and since that time the orders for his machinery have been constantly so pressing as to employ the entire capacity of his works.

The Crompton Loom Works are able to produce from two to four broad fancy looms a day, and are, in fact, the chief producers in the United States of this specialty. Mr. Crompton also manufactures fancy cotton and gingham looms, which, with four shuttle boxes, run at the unprecedented speed of one hundred and fifty to one hundred and seventy "picks" a minute, according to the size of the shuttle and bobbin used. Mr. Crompton also makes fancy cotton looms with a large number of spindle boxes, and an extensive number of harnesses adapted to the manufacture of fancy cottonades, ginghams, poplins, shawls, etc.

In manufacturing the leading looms for woollens, Mr. Crompton preserved the configuration of the machine as built by his father, until 1865, when he discarded it for the "upright lever arrangement," for the harness motion, the exclusive right to manufacture which is under his control. But finally he discarded this, and has now adopted a principle in which no jack levers at all are used, and involving many important advantages over any loom hitherto built. These improvements are of Mr. Crompton's own invention, and are under his exclusive control, and are very popu-

lar among the manufacturers of fabrics, who frequently render voluntary testimony, by letters, to Mr. Crompton of its great value. Mr. Crompton has received over thirty letters patent for improvements in looms, and is constantly exercising his inventive talents in further improving the loom, and his other inventions.

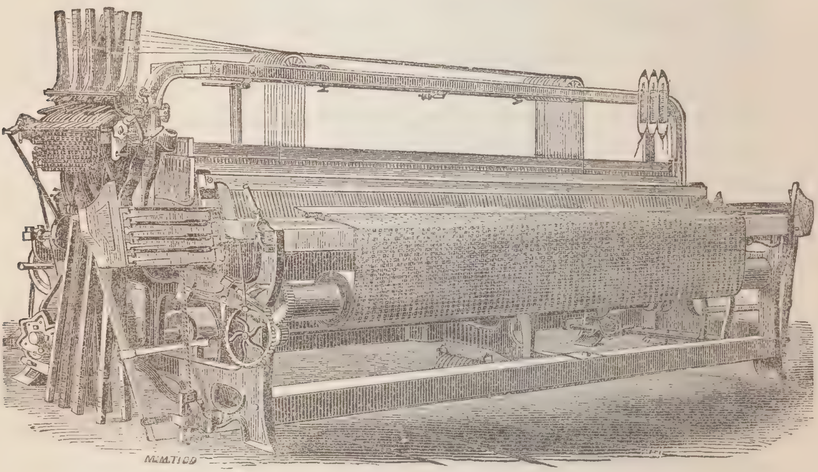
The number of pieces in a broad fancy loom for woollens is two thousand four hundred and forty-one, consisting of the framework, the harness motion, the treadles, the drop box apparatus, the lathe, warp beam, etc. The cost of a large loom with four drop boxes is about four hundred dollars. The frame, and all but the shafts, are cast.

Portions of the cast-iron pieces are ground and polished on large grindstones and emery wheels. The works are provided with self-feeding chucking lathes, which were invented in the factory, and which not only guide themselves, but stop when their work is finished. The "picker spindles," cut of the proper length from rods of steel, are made perfectly round and smooth in an ingenious machine, called the "spindle polisher," by which, at the same time, the spindles are, if necessary, pointed and polished with great accuracy. The power for the works is obtained from a Corliss engine of thirty-horse power, made by the Corliss Steam Engine Company, of Providence, R. I., and which has been supplemented by another of twenty-horse power for doing the grinding and polishing required in the various processes of manufacture.

After the castings are cleaned, they are first passed through the self-feeding chucking lathes, and bored with the requisite holes. Then they are subjected to the operation of planers, and the picker slots and the drop-shuttle boxes are made perfectly true and parallel with the lathe, in order that the shuttle may be thrown with accuracy through the warp. In the shafting room, the shafts and crank shafts, the driving pulleys, beam heads, and gearing of the looms are turned, polished, and fitted. In this shafting room are various other mechanical appliances of the same character. In the finishing room are many machines for turning, drilling, screw-cutting, etc., required for the small work of finishing the looms. In the punching room are numerous machines for making washers, and other necessary parts, and also for filing the small boxes made of malleable iron. In the shuttle room, where the shuttles are made, these necessary portions of the loom undergo nineteen operations before they are finished, such as sawing out, slabbing, squaring, burring out, pointing, heading, etc.

The "fancy loom" is distinguished from the common "cam loom" by its "harness" mechanism, by which the operator of the loom is enabled to arrange it at will so as to produce any required combination of the twenty-four harnesses, in order to weave the various patterns of fancy cassimeres, for example, or any other variety of fabric which is manufactured in it. The ordinary loom produces plain cloth alone.

The movable, or "drop-shuttle" box, containing the different colored fillings in the shuttles, and the pattern chain, for producing the different interweavings of the warp and woof, are the chief distinguishing features of the fancy loom, as compared with the



BROAD FANCY LOOM.

plain loom. The shuttle boxes, one in each box, are made in four parallel divisions, into each of which a given color of "filling" is put. The "chain" is a series of small spindles, united by links, or flexible joints, and set parallel to each other. These may be of any required number, from two to several hundred, upon which are strung a number of small iron "rolls," or wheels, divided from each other by washers. By any of the rolls or links of the twenty-four on a spindle of the chain, it is determined whether a particular part of the warp shall go in the upper or lower portion, or "shed," as the technical term is, which is formed for the passage of the woof, or filling.

The chain is set on the end of the loom, in such connection by

the harness bars with the several harness frames, as to lift a particular one at a given time, or depress it at the instant when the proper shuttle is ready to pass through the woof. The number of harnesses may be twenty-four, in each of which may be set from any number to two thousand "treddle" wires, in each of which is an eye, or loop, through which a thread of the warp passes. These harnesses occupy a space of nine inches, so that within the space of an inch several hundred combinations of color are possible.

AMERICAN LEAD PENCILS.

IDENTITY OF DIAMOND, CHARCOAL, AND BLACK LEAD. — ANCIENT SUBSTITUTES FOR LEAD PENCILS. — DISCOVERY OF THE BORROWDALE MINE IN CUMBERLAND. — MODE OF WORKING IT. — MODE OF USING IT. — EXPERIMENTS FOR USING INFERIOR GRAPHITE. — THE FABER HOUSE. — THE AMERICAN LEAD PENCIL COMPANY THE ONLY COMPLETE WORKS IN THE UNITED STATES. — GEOGRAPHICAL DISTRIBUTION OF THE MINERAL. — THE AMERICAN COMPANY'S WORKS. — STYLES OF PENCIL. — OPERATIONS ON THE LEAD. — OPERATIONS ON THE WOOD. — CRAYONS. — CAPACITY OF THE WORKS. — SUCCESS OF THE AMERICAN PENCILS PROVED BY PRACTICAL USE. — HIGH CLASS OF TESTIMONIALS.

DIAMOND, charcoal, and black lead (plumbago or graphite) are different forms of carbon. Little is known of the way in which the diamond crystallizes, though some small artificial black ones are believed to have been made by a French experimenter. There is a tendency to believe, however, that both diamond and black lead are ultimately of vegetable origin; the latter, perhaps, being the remains, in the primary rocks, of some vegetation which existed when those rocks were at the surface of the earth, just as the anthracite and bituminous coal deposits are the remains of the vegetation of a subsequent geological period.

The use of black lead for writing and drawing is of obscure origin; for the references to something which may or may not have been a black lead pencil, by Van Eyck about the beginning of the fifteenth century, Memmling a little later, and by Italian writers somewhat earlier, are very uncertain. Gesner, writing in 1565, has also been thought to describe a kind of black lead pencil. But it is probable that the pencils referred to as above by the Flemish and Italian authorities were plummets or rods of lead only, or lead mixed with tin. The Italians called a pencil *stilo*, from the Latin *stylus*, and they called the kind of pencil — whatever it was — *silver style*. Now, a leaden or pewter rod might look something like silver, while a black lead one certainly would not. Gesner may possibly have referred to a real black lead pencil; for it was in 1564, one year before the date of his reference, that the celebrated English mine of

Borrowdale in Cumberland was discovered, and in 1565 that the first pencils were made of it.

The graphite from this Borrowdale mine used to be taken out with as much precaution as if it had been diamond. Indeed, it was worth more than any ordinary diamond mine; for it used to produce to the owners from $150,000 to $500,000 annually. It was only opened for six weeks once a year; a limited quantity was taken out, which was shipped to London, and sold once a month at auction; and the mine was then shut. Thefts by the miners of the neighborhood were frequent. A sturdy gang of them once seized the mine by force and worked it for some weeks; and the monopolists in their desperation at last had to practise closing the mine by hauling some hundreds of cart-loads of rubbish into it, and then flooding it full of water, and while it was open an armed guard was maintained at its mouth.

This graphite, as long as the supply held out, was the best in the world; but the mine has now been long exhausted, and only furnishes small quantities of inferior mineral, much of it extracted from the refuse of better days. It used to be manufactured thus: The crude blocks or lumps were scraped clean and sawed into plates of the thickness of a pencil lead; then a grooved stick was taken, one edge of this plate set in at one end and broken across even with the groove; then the plate was laid into the groove again, close to the end of the first piece, and again broken across; and so on until the groove was filled, when a piece of wood was glued on above it, and the pencil rounded into shape.

A number of processes were tried for working up the inferior lead, by pulverizing it and mixing it with glue, isinglass, tragacanth, and other gums, by melting sulphur with it, and by mingling it with antimony, etc., but with little success. Mr. Brockedon, an Englishman, invented a mode of applying enormous pressure in a vacuum, which served to make a very fair article, and M. Conté, a Frenchman, as early as 1795, developed a process, which has been adopted in most or all of the modern pencil manufactories, for a manufactured article or "artificial black lead," whose color and hardness can be graded at pleasure, by mixing with the graphite, after grinding it, different proportions of pure clay, very finely pulverized.

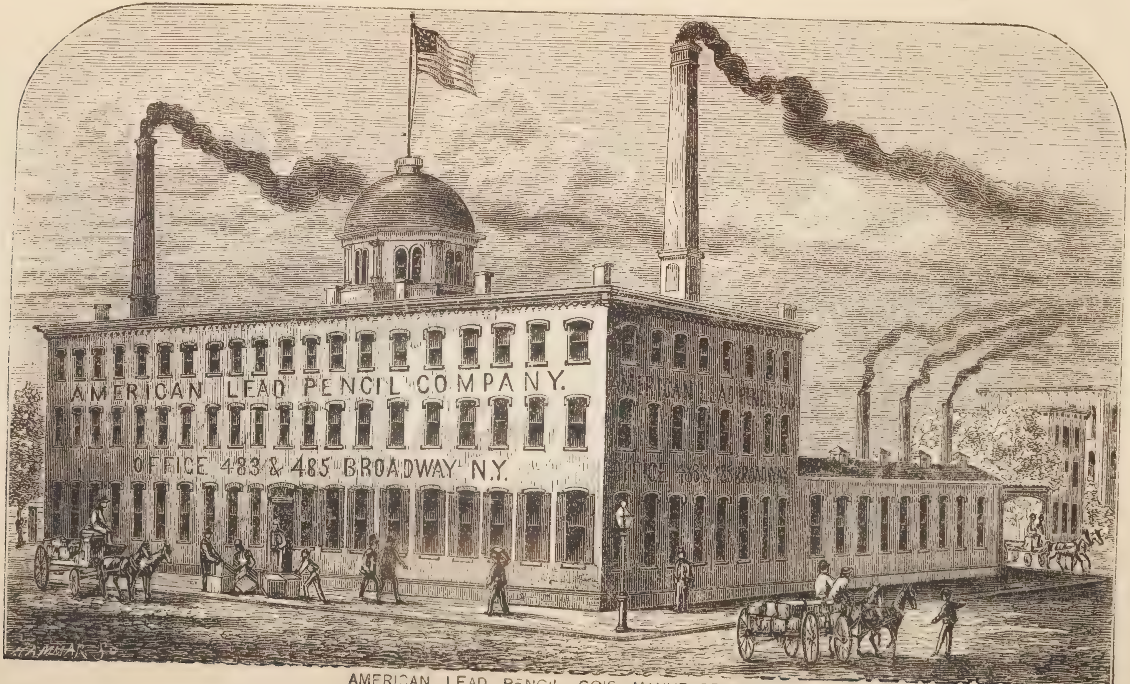
The well-known house of Faber, which dates back to the year 1761, was for a long time the foremost in the lead pencil manufacturing business, and it has for many years had a branch concern in New York, which, however, manufactures no leads here, but imports some of the poorer grades, putting on the wood in this country, while the better pencils are wholly made in Europe.

The business of manufacturing the pencils complete, however, upon an independent basis, on a large scale, by scientific methods, and with a complete suit of the proper machinery, has been established in this country by the enterprising concern of the American Lead Pencil Company, composed of Edward Weissenborn, the manufacturing partner, and the Messrs. Hecht Brothers, the selling partners, whose office is at 483 and 485 Broadway, New York City, and this is the only concern which manufactures pencils complete on this side of the ocean.

Most of the graphite used for the American Lead Pencils is obtained from Georgia. Other deposits of it are known in Pennsylvania and elsewhere. Indeed, it is procured from various parts of the world; in Spain, Ceylon, Norway, Scotland, etc., etc., and some noise has been made of late years about a deposit, supposed to be of vast extent, in a mountain of the Saian range, west of Irkutsk, on the southern frontier of Siberia, close to the Chinese boundary. This was discovered about 1850, by a Frenchman named Alibert, who had found lumps of graphite in the beds of streams coming from that direction, and who persevered in following up the indications until he reached the mine itself. This deposit is unquestionably of great value, but in the present state of scientific mineralogy, mining and manufacturing monopolies have become much less practicable than heretofore, and the lead pencil manufacture in the United States is little dependent on any particular mine.

The processes used at the European black lead pencil manufactories are much more scientific than the rude method which was above described as employed with the Cumberland lead. Indeed, in the factory now running at the old Borrowdale mine, where the poor remains of the rich local deposits are used, as well as raw graphite from other places, similar improved means have necessarily been employed in order to utilize the only attainable material. These means have a general similarity with those of the American Lead Pencil Company, but the American ones have the further great advantage of a connected group of twenty-eight different patents for improved machinery and processes, in all parts of the manufacture; all for inventions by Mr. E. Weissenborn, the actual superintendent, an accomplished mechanician and able manager.

The number of different styles of pencils called for by the public, from the commonest school pencil up to the very finest grade for artists, and regularly manufactured accordingly by the company, is surprising. Including several styles of colored pencils or crayons,



AMERICAN LEAD PENCIL CO'S MANUFACTORY.

it makes three hundred and sixty different sorts of pencils. They differ in goodness and price according to the excellence of the materials used; or in "grade," or hardness, according to the kind of lines required; or in form, size, or outer finish of the wooden casing, according to the taste or employment of consumers.

Black lead pencils are made of fourteen different grades of softness, varying from H H H H H H, the hardest, to B B B B B B, the softest. The hardest are used by engineers and artists for drawing the very fine, clear lines required in mechanical drawing, in parts of drawings on wood for engravers, and similar purposes; while the softest are for the darkest shadings of artists' designs.

Two distinct trains of operations are carried on in the American Lead Pencil Company's Works, besides the subsidiary labor of making boxes and printing labels and besides a machine-shop, where the company makes and repairs its own machinery. Every machine used on the premises and in the pencil manufacture proper, indeed, except the steam-engine itself, was made in the Company's own machine-shop. This renders the system remarkably complete and independent; so that, provided raw materials, lodging, and subsistence could be procured, the works could be run independently of the earth, almost as well as the earth independently of the works.

In describing the operations which result in a lead pencil, it will be convenient to begin with the experiences through which the black lead is carried. The works are at present situated in a quiet spot in Hudson City, N. J., just on the brow of the steep pitch which separates the upland from the low-lying grounds on which Hoboken is built. An elevator, or rather a steeply inclined railway, lies on the face of this hill, and the heavy materials required are hauled up this by means of a drum with a wire chain, worked by the steam-engine. Up this railway comes the crude black lead, in casks weighing from eight hundred to one thousand pounds each; a soft crumbly black powder with lumps all through it, having its own well-known peculiar greasy feeling and gloss. First of all, this is refined by being mixed with water in a series of tanks, where it is stirred and left to settle, transferred and stirred and settled again, over and over, the impurities being gradually thrown out and the lead itself assorted by qualities. When this is done, about one fourth of the original quantity has usually been rejected as grit, earth, etc. The remainder, having the appearance of a very choice article of glossy black mud, is scooped into shallow saucers of pottery, like those used for flower-pots, but of a large size, measuring, say, ten inches across;

and in these, like so many mud pies, the precious stuff is placed in a drying-room kept a good deal hotter than is comfortable, — say at 120° Fahrenheit, — and kept there until the moisture is thoroughly driven off, leaving, of course, hard dry pies, or disks of lead.

The third process is to crush these disks in a dry mill; the fourth, to grind the materials, under a heavy muller in a circular trough, into another but different and finer grained mud, which now becomes possessed of a surprising degree of tenacity.

The mass is next subjected to the action of a screw press of three hundred tons' power, under which it finds no escape from its agony except by spirting out through one small hole provided for it in a little solid brass die about as large as a small thimble. The hole through the middle of this die is of the shape and size of the lead, — square, hexagonal, or oval, large or small, as the case may be. There are almost sixty different dies in all; and it is in passing through these dies that the first appearance takes place of anything like a pencil lead. It is no single completed straight dry lead, however, but an endless, damp, soft, tough, black string or strap, which is quietly coiled on a board as it runs down through the die, the board being moved back and forth and across and across, so as to bring the coil to a long oval.

Next, this string is lifted from its board, a length at a time, and laid across another board about three times as long as a pencil, in straight lengths, each piece being nipped off from the coil as it is laid against its predecessor. These pieces are carefully kept smooth and straight; and on this board they are subjected to a long, slow, delicate, baking process, from which they emerge with all the qualifications of a pencil lead.

Being next cut into the proper lengths, they are ready to be cased with wood, and are stored, sometimes in immense numbers, waiting for the cedar cases, in which they are to be consumed.

Now for the wood. A small quantity of whitewood is used for some inferior pencils, but nearly all the pencils made are cased in red cedar. This is cut in Florida, and shipped direct by the whole cargo to the works. Some logs are brought measuring as much as three feet in diameter; so that the tree grows to an incomparably greater size in that warm climate and calcareous soil than in the North.

Having been hoisted up to the works, and stacked for a time, the log is hauled into the saw-mill, where it is speedily cut into planks whose thickness is equal to the width of four pencils. These are sawed again into laths, whose width is the thickness of the plank;

and in this condition they are seasoned. They are first placed in long criss-cross rows in the open air, giving the place the appearance of a greatly expanded and fancifully arranged lath-yard. When sufficiently treated by the open air, rain, and sunshine, they are placed in a drying-room, and brought to the proper condition for being worked further.

Next the laths are cut to pencil lengths, that is, of course, into strips as long as one pencil and as wide as four. At this point most of the imperfections of the cedar are rejected; and it is found that almost half the bulk of the wood imported is wasted, from sap, shakes, knots, decay, etc. No scorpions, centipedes, or other troublesome insects, have ever been brought north in the logs, but a few snakes have been found coiled up in the hollows of the wood. No accidents have, however, happened in consequence, except to the snakes.

These seasoning processes usually occupy about two weeks. The next thing is to groove these blocks on one side for the leads of the four pencils, and on the other for the divisions between them. This is swiftly and noisily done by a clean-working little grooving machine. Then, after some trimming and smoothing, the lead and the wood for the first time come together, like those Oriental brides and bridegrooms who see each other for the first time at the marriage which unites the rest of their lives. In order to do this, the lead is dipped in glue, laid into its grooves, and a thinner slip, just half the thickness of the grooved one, is glued upon it.

The pencils now exist, but in groups of fours. After a little more trimming, they are piled into a pipe that lets them down flat-ways upon a table of another noisy hurrying little machine. As each touches the table, a finger comes up behind it and quietly pushes it out to a set of saws that divide it into four pencils, which are instantly driven forward again into a shaping machine, from which they fall — round and practical cedar pencils at last — into a box.

But this is not all. Next they are polished, being laid on an endless belt that carries them rolling along under a set of furiously vibrating emery surfaces, from which they come out all warm and shiny, like a little boy rubbed very hard with a crash towel after being bathed. Then comes the coloring, first with a dead color, which is then brightened and afterwards varnished. A very ingenious mode of painting with rapidity and effect is used at this stage of the manufacture. A considerable number of pencils are stuck into a box, along with a supply of coloring matter in very fine powder, and this box is then closed and placed in a shaft so geared as at once to

whirl the box round and round and to shake it back and forth in the direction of the length of the pencils. This swift rubbing and jolting brings it to pass that the pencils color themselves with great rapidity, and very thoroughly too.

Last comes the lettering, and for once we come to a process through which the pencils have to pass one at a time. It has no doubt been noticed thus far how continuous has been the method of dealing with groups; a method which is remarkably well carried out in all parts of the company's processes as far as possible, and which forms a striking contrast to the ancient Borrowdale plan of cracking off one piece of lead after another, perhaps half a dozen times, into one pencil at a time. After the lettering, the pencils are ready to be assembled, papered, and packed for sale, and the work is done. All the labels are printed on the premises, on a neat hand-press, all the paper and paper boxes used in packing are cut and manufactured there, and all the paints, dyes, etc., are prepared there. Provided the wood were sufficiently dry, and the leads were ready, it would require but four days to fill an order, from log to pencil.

In tracing the course of these operations, the history has been closely limited to an ordinary style of pencil, say the black round No. 2, which is that most extensively used. For every thousand No. 2 pencils are used, it is found, about three hundred of No. 1 and No. 3, and seventy-five of No. 4, these four numbers being the ordinary range. Of No. 5, for instance, only about twenty are called for to one thousand of No. 2. Of the colored crayons, or red, blue, yellow, and green pencils, about one twentieth as many are used as of lead pencils. The process of manufacturing these closely resembles that for the lead, being done with the same machinery, and the clay used — a fine pure porcelain clay — being the same that is mixed with the lead to adjust the grades of the pencils. The extent of the operations of the concern may be judged of by one total. The method pursued is to run the mill on one class of pencils until there is a sufficient stock for a reasonable extent of future orders, then to take up another, and so on. If now the company were out of No. 2, they would make up under ordinary circumstances ten thousand gross of that style, — that is one million four hundred and forty thousand No. 2 pencils, — and then proceed to another. The works as at present organized, with a few additional hands at some points of the process, could turn out about six hundred gross, that is eighty-six thousand four hundred pencils a day.

There are a few variations in these pencils, which have not been

mentioned. Such are the bone tips sometimes used, also made on the premises; and the india-rubber tips, these being purchased ready made.

The machinery, which is carried by a sixty-horse-power steam-engine, and the one hundred and fifty hands employed (about eighty of them being women), do an amount of work that would require at least six hundred persons, all working by hand. The premises are airy and pleasant, and many of the rooms are agreeably perfumed with the cleanly aromatic scent of the cedar.

In the operations of such a concern as this is illustrated the immeasurable progress of the modern arts. The object that was a hundred years ago reached by many a country school-boy all alone, with a lump of lead, a skillet to melt it, a mould to shape, it and a jackknife to whittle it, is to-day sought with an elaborate train of heavy machinery, the united operations of mechanics, natural philosophy, and chemistry, materials imported from the very ends of the earth (such as those used in colors, india-rubber, chemicals, etc.) by a force equal to almost a regiment of human beings, and an investment of capital that would buy a dozen farms. And yet, most wonderful of all, the thing made by such vast expense and labor is both beyond comparison better than the plummet, and actually cheaper!

As a handsome tribute to the high excellence of a strictly American manufacture, it is proper to state that the peculiar claims of the American Lead Pencil Company to manufacture pencils at least equal to the very best in evenness of quality, freedom from grit, smoothness of texture, ease in marking, and tenacity of point, — not to mention the advantages which their very complete machinery and organization give them in fixing a cheap price on their goods, — are fully upheld by the reports of their patrons and by public testimonials. A long list of public officials, civil engineers, artists, and instructors in drawing, are on record in high commendations of these pencils; among whom, for instance, are Professor Hertzberg, of the Art Department at the Brooklyn Polytechnic Institute and at Cooper Union; Professor Louis Bail of Yale College; Ex-President Thomas Hill of Harvard College, etc., etc. In the praises bestowed by these gentlemen, few of them omit to advert to their gratification at being relieved from a dependence on foreign manufactories for a superior quality of pencils. Premiums were awarded to the Company, moreover, by the St. Louis and Maryland Institute fairs of 1866, the medal of the Paris Universal Exposition of 1867, the Cincinnati Industrial Exposition, and a certificate of award at the

American Institute Fair of 1871. In consequence of the increasing demand for these pencils, and their growing popularity, the company are compelled to build a larger and more convenient factory at Hoboken, N. J., which is now in course of erection, the dimensions of the main building being 125 by 113 feet, and three stories in height. Such an evidence of the reward which attends a scientific and accurate attention to supplying the needs of society, even in the seemingly modest department of pencils, is a fit subject for congratulation, as a proof of how surely the organization of our society is normally tending towards a complete integration of its various parts.

RULES.

THE DIFFERENCE BETWEEN SCIENTIFIC AND ORDINARY KNOWLEDGE. — MAN AS A MEASURER. — THE NEED FOR RULES. — AN ACCOUNT OF HOW THEY ARE MADE. — BOXWOOD. — ITS PRODUCTION. — THE FACTORY OF STEPHENS AND COMPANY. — THE PROCESSES OF RULE-MAKING. — THE MACHINERY USED IN THE BUSINESS. — MR. D. H. STEPHENS AS AN INVENTOR. — THE STEPHENS PATENT COMBINATION RULE. — THE VARIOUS USES TO WHICH IT MAY BE APPLIED.

THE ability to measure accurately, and thus obtain a definite and positive knowledge, instead of a general and indefinite knowledge of form, relation, distance, and the other phenomena of the existing condition of things in which we are placed, constitutes the difference between scientific knowledge and ordinary knowledge. By some philologists our term *man* is traced to a derivation from the Aryan root-word *ma*, to measure. Whether this derivation is true or not, certain it is that the most accurate and comprehensive definition of man, as classified at the head of the organic evolution of intelligence upon this planet, is that of a measurer, and, as symbols of his true domination of the world, a rule and a pair of scales would be much fitter and more expressive of his glory than a crown and a sceptre.

The use of the rule is so absolutely necessary in almost every mechanical or artistic pursuit, that the consumption is, of course, very great, and the manufacture is consequently a very important one. Rules are generally made of boxwood or of ivory, and are mounted and tipped with brass or silver. Boxwood is most extensively used, both on account of its being more plentiful than ivory, and also because it is less liable to expand and contract by variations of the temperature. This last consideration is the most important, since the accuracy of the rule depends upon the constancy with which it marks the fixed standard for lineal measurement.

The boxwood used by the chief manufacturers of rules grows in Turkey and Southern Russia. The forests in which it is produced are under the control of the respective governments, and are farmed out, or leased to special contractors, who pay for the privilege by a

certain percentage of the income from the sale of their produce. The forests within the jurisdiction of Russia are leased by the government of that country to two persons, who have full control of the cutting and disposition of the boxwood. These forests occupy mountain ranges for the most part. The boxwood is cut, and after a suitable time brought down from the mountains to the market or depot for sale, on the backs of mules.

The tree producing boxwood, known botanically as the *buxus*, whence our name for it, is small in size, the average diameter of the logs which reach this country being from six to seven inches, and never more than fifteen. The boxwood imported by our manufacturers is now brought directly from the depots in Russia and Turkey to New York and Boston, by the way of Smyrna. Formerly it was taken to Liverpool, and there transshipped to this country. Boxwood is sold by weight, the prices varying from thirty to one hundred and fifty dollars a ton, the value depending upon the texture, color, and straightness of the grain; the color being an important consideration. The deeper the golden tint of the wood, the more valuable it is for rules.

The manufacture of rules is extensively carried on in the United States, and from its extent, and the multiplicity of interests which depend in a greater or less degree upon its accuracy, by which their own is regulated, it may be justly classed as one of the great industries of the land. The leading manufactory of the United States is that of Stephens and Company, at Riverton, Litchfield County, Connecticut. Their factory is situated on the Tunxis, a small river, which is one of the chief branches of the Farmington River, and which at this spot supplies a good water-power. The establishment of Stephens and Company has mainly grown up under the fostering care of Mr. DeLoss H. Stephens, who unites with the character of an able and indefatigable business man the genius of a first-class practical inventor, and who, by machinery of his own invention, has greatly promoted the manufacture of rules in this country. The most important inventions which Mr. Stephens has made have been wisely kept within the knowledge of Stephens and Company, and secured to their special control, not by letters patent, but by private use. By the aid of these machines, and improvements in others, which have been secured in the same way, Messrs. Stephens and Company have been enabled to manufacture the best quality of rules in the market, at less cost than many of their competitors have been able to. Some of Mr. Stephens's inventions have, however, been patented.

By the lessening of the cost of production brought about by the use of their machinery, Messrs. Stephens and Company are enabled to give the purchasers of their rules more perfect and more conscientiously made wares at lower prices than their competitors can well afford, and thus they have risen to their eminence in this branch of manufacture.

The making of rules is a nice art, and quite interesting in its details. The boxwood logs, on their arrival at the factory, are first "blocked up," or sawed into proper lengths or sections, which are then quartered, or split into four minor sections, which are then slabbed or cut into pieces about the width of a rule. These slabs are then slit into pieces about an eighth of an inch in thickness. The next process is to "dress off," or gauge, each piece as to its broader surfaces, or sides, and its edges, into the required shape and size. This is done rapidly and perfectly by an automatic machine of ingenious contrivance.

The "stuff," as the pieces of boxwood are called, is next fitted or adjusted to the kind of joints to which the pieces are finally to be united. These joints are respectively called "head joints" and "middle joints." The next step is to "tip" the boxwood pieces, that is, to fit the brass or silver caps upon their ends; brass being chiefly used for mounting the boxwood rules, and German silver, or real silver, for the ivory rules. Pure silver mountings are too expensive for the general demand; though on the occasion of our visit to the factory of Stephens and Company we saw several splendid ivory combination rules made to the order of Governor Claflin of Massachusetts, and other "republican sovereigns," which were mounted with pure silver.

The brass used in the manufacture of rules is brought to the factory from the rolling-mills, in sheets prepared for the purpose, and is slit by circular shears and saws into proper sizes, and then cut with dies into the forms needed for the construction of the joints, caps, bindings, etc., which are used in the rules. The joints of the rules made by Messrs. Stephens and Company are, by peculiar machinery, "scraped," or trimmed; this process doing away with the slower one of filing, milling, etc., and leaving the work more perfect. The machine which does this is the invention of Mr. DeLoss H. Stephens, and is patented.

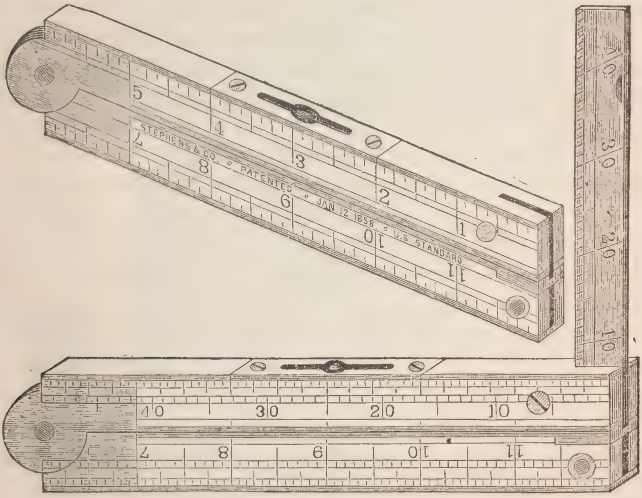
Uniting the several pieces which form the common joint is done in this factory by a "driving machine," which performs this work at least one hundred per cent. more expeditiously than the hand method

of driving which formerly prevailed. The "rolls," or collets, or the cylindrical parts of the rule joints, or shoulders over which the jointed parts of the rule turn, are made here by an ingenious automatic machine, with a great saving of labor and material. Everything in the establishment, even to the cutting of the pins, of which about twenty enter into the construction of a plain rule and forty into that of a bound rule, is done by machinery instead of by hand, as was formerly the practice. The heading of the rivets and the marking out of the "arches" to receive the joint-caps are also done by machinery.

After the work is put together and made ready for undergoing the process of "graduating," it is taken to the graduating room, where the lineal gauging is performed. The machines by which the surface of the rules is marked into inches and parts of inches are automatic in their operation, and quite complicated in their construction, and perform their work with more than human accuracy, and with almost living intelligence. These machines are the inventions of Mr. DeLoss H. Stephens, and alone would be enough to secure for him a place among the first scientific mechanical inventors of his time. Their work is neat, delicate, perfect, and rapidly performed. While these machines are necessarily so complicated in their construction, yet they are so simple in their action that they can be safely left to be operated by a boy.

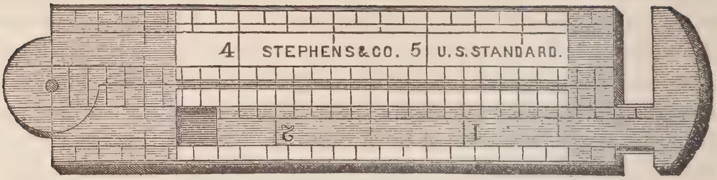
After the rules are completed, they are then thoroughly inspected, any blemish or fault, however slight or trivial, condemning them. Stephens and Company manufacture over one hundred different varieties of rules, which are in demand all over the United States, in Australia, South America, and in Europe also. Some varieties of their rules are manufactured solely by Stephens and Company, among which is the celebrated "Stephens' Patent Combination Rule," a cut of which is here given. This rule, an invention of Mr. L. C. Stephens, the founder of the business and the father of the present owner, is made of boxwood or ivory, and combines in itself a carpenter's rule, spirit-level, square, plumb, bevel, indicator, brace-scale, draughting-scale, T square, protractor, right-angled triangle, and with a straight edge can be used as a parallel ruler. It has but one joint, and is bound with brass. When folded it is six inches long, one and three eighths inches wide, and three eighths of an inch thick. The cuts, which are just half-size, represent the rule in three positions: first, as a spirit-level; second, as a try-square level and plumb; when partially opened it serves also as a slope-level.

The angles formed by the blade and leg *decrease* just one half as fast as the angles formed by opening the legs of the rule *increase.* The upper edge of the other side of the blade is graduated into inches and eighths, and thus shows the *pitch to the foot.* The inner edge of the leg which holds the glass is also graduated to measure the angles which are formed by turning the blade in the leg which holds it. These degrees show how much the right angle is reduced as the blade falls from that position. As a T square it is also a right-angled triangle. One side of the blade is divided into twelfths, also the inside edge of the leg which holds it, thus constituting a brace-scale.



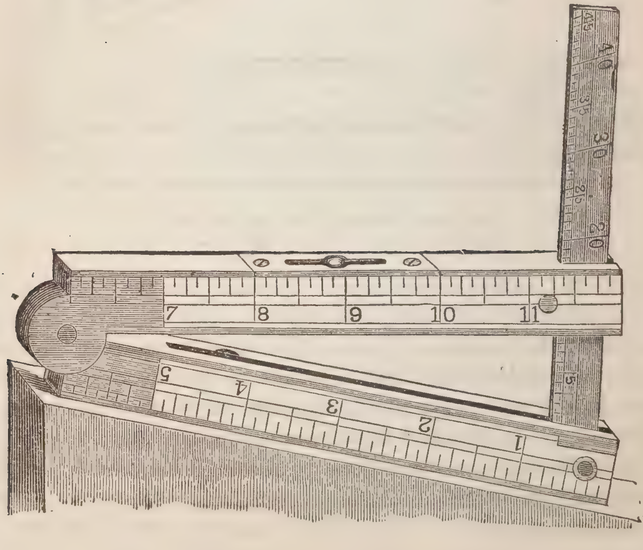
Stephens' Patent Combination Rule.

The sloted screw which passes through the end of the leg is used in adjusting the square, should it require it. By this simple arrangement for measuring angles, this rule becomes invaluable to practical mechanics of all kinds, as well as to surveyors, draughtsmen, architects, and every one who knows the value of an instrument by which he can readily and reliably measure whatever he may wish; and its universal use, as tending to diffuse a habit of acquiring an accurate and scientific knowledge of form and distance, would prove a most valuable educational assistance, and one which is thoroughly in the spirit of the times, which tends to replace vague and general conceptions of things by the accuracy of positive knowledge.



Stephens' Caliper Rule.

The above cut represents a caliper rule, also manufactured by Stephens and Company. The value of this convenient device for measuring accurately the diameters of round and cylindrical bodies is too well known to persons who have practically become acquainted with it to need more than the simplest mention here. In the other cut, the combination rule is shown as a slope-level, or Inclinometer.



Combination Rule as an Inclinometer.

BROOMS.

THE DERIVATION OF THE WORD "BROOM." — THE MATERIALS FROM WHICH BROOMS ARE MADE. — THE PROVERBS SUGGESTED BY BROOMS. — THE CULTIVATION OF BROOM-CORN. — THE PROCESS OF MAKING BROOMS. — THE EXTENT OF THE MANUFACTURE. — THE EMANCIPATION OF WOMEN FROM THE USE OF BROOMS.

THE broom is a well-known implement of the house, used to sweep away dirt and dust, and is therefore most essential to order and neatness. There are brooms in England called heath brooms, because they are made of a small shrub growing on the sandy heaths of Great Britain; a similar shrub is found in great abundance in Spain, and is doubtless the same of which Pliny speaks as covering the mountains near Carthagena. This shrub is called in England *broom*, and is supposed to have given the name to all implements for sweeping, though made of different materials. There are also birch brooms, which are bundles of twigs, used for sweeping stables and streets. Brooms are sometimes made of hair, formed by the insertion of a number of tufts or knots of bristles into holes bored obliquely in a stock of wood.

The word *besom*, meaning broom, is used by the Hebrew Isaiah in speaking of the destruction of Babylon: — *I will sweep it with the besom of destruction;* concerning which it has been quaintly said, — "When a people will not be made clean with the besom of reformation, what can they expect but to be swept off the earth with the besom of destruction?" There is an old English proverb which says: —

"A new besom sweeps clean."

This is generally applied to new servants who are very diligent, or of newly appointed officers who are very strict and scrupulous, or of new pretenders to friendship who are very officious. When those long in office become dishonest and corrupt, the broom of reform or removal is necessary, and is a proper figure for the expression of public indignation. Another old proverb suggested by this useful article of the house is: —

"Sweep before your own door."

This proverb is designed as a reproof to those persons who are continually interfering with the affairs of others, and at the same time neglecting their own. It is thus that persons

"Scald their own lips with other folks' broth,"

or meddle with what they have nothing to do.

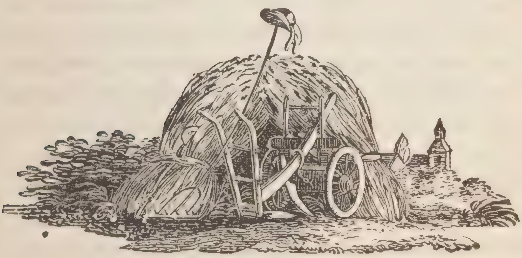
The material of which brooms are generally made is a kind of *sorghum* called broom-corn. It is supposed to be a natural product of China or India, but is now widely cultivated in Europe and America. It has a jointed stem like a reed, and grows from six to twelve feet high, having a bushy top of which the brooms are made. The stock is hard and dry without nutriment, and is regarded as of no value except for manure. The sorghum, of which, in Europe, only brooms are made, is cultivated on a large scale and with great care in China. It attains an astonishing size; its stalks are strong and solid enough to be used with advantage in the construction of farm-houses and palings. It furnishes a considerable quantity of large seeds, which the poor eat instead of rice, and from which, by distillation, a liquor may be obtained containing a large proportion of alcohol.

The cultivation of broom-corn is a branch of industry in most of the States, and considerable profits are derived from the manufacture of brooms, and the exportation of unmanufactured brush and broom handles. The seed, planted in rows or hills, germinates very rapidly; the plants require no more care than is usually bestowed on the cultivation of Indian corn. The average product of brush to the acre is about 500 pounds. The seed is separated from the brush by scraping machines, some of which, in large establishments, are moved by horse-power. The seed is used for fattening sheep, for feeding poultry, and, when ground with Indian corn or other grains, may be profitably fed to cows, cattle, and horses. The value of the seed is often greater than the entire cost of cultivating and harvesting the broom crop.

In the manufacture of brooms, very simple machinery is used, consisting of a wood roller, turned by a crank for the purpose of winding on the cord. One hand holds the broom-handle, and, while winding on the twine, the brush is supplied with the other. The machine has also a bench and a rag-wheel to hold the cord when wound on the roller. With this simple machinery one man may make from five to eight dozen brooms in a day, when all the materials are prepared to his hand.

The Societies of Shakers in the State of New York are engaged largely in the cultivation of broom-corn and in the making of brooms, though in many other States this branch of industry receives attention. In the year 1860, nineteen States were reported as producing a greater or less number of brooms. In the State of New York they were made during that year to the value of $409,193; in Massachusetts, $328,694; and the total value in all the States was reported at $1,364,286. The brush of brooms and broom-handles are exported to England with more profit than if exported already made.

The chief consumption of brooms is made by women, on whom the dirty and disagreeable duty of sweeping appears to have devolved, as an evidence of their inferior condition, in a state of barbarism. With the new era, however, which they are claiming for themselves, a more intelligent method of constructing and furnishing our houses will unquestionably lead to a state of things in which the necessity for the dirty work of sweeping will be in a great measure abrogated, and women be freed from this servile duty, and the men be relieved from the annoyance of the process, the results of which are desirable, but which can be better attained by prevention, and by habits of greater cleanliness.



GOLD MINING.

THE YIELD OF GOLD BY THE UNITED STATES. — THE PRODUCTION OF CALIFORNIA. — THE ROMANCE OF GOLD MINING. — THE REALITY OF SCIENCE. — THE ORIGIN OF GOLD. — THE PROCESSES OF GOLD MINING. — WASH MINING. — QUARTZ MINING. — THE STAMP MILL. — CHEMICAL PROCESSES. — THE YIELD OF GOLD AT PRESENT. — THE DIFFERENTIATION OF INDUSTRY AT PRESENT IN CALIFORNIA. — THE GREATER PROSPERITY OF THE STATE. — THE USES OF GOLD.

Gold, the most valuable of the precious metals, and for its ductility, its beauty, and durability, the most serviceable of them all, occurs in many parts of our country, and gives occupation to a large army of workers. The hills composed of granite slates, which flank the peaks of the Alleghany range on the east and south, have since the settlement of the country furnished many million dollars' worth of this metal. Up to the year 1867, Virginia had yielded a million and a half of gold, North Carolina nearly ten millions, South Carolina a little more than Virginia, and Georgia about seven millions, making in the aggregate twenty millions. This is only about one third the annual gold product of California during the years '52, '53, '54, and '55. These figures show how great the development of the mining interest in the country has been since the startling discovery of 1848 at Sutter's Ranch.

In that year, a laborer at work on the foundations of a saw-mill saw the yellow particles, the fame of which was to stir the world. The excitement which blazed out and lasted for three years following the discovery has seldom been equalled. The years '49, '50, and '51 saw such vast additions made to the bullion of the world that a serious alarm filled some minds that the commercial value of gold would be upset, and that the coinage of Christendom would be permanently deranged.

Three years after California was added to the gold-producing

areas of the world, the magic mineral was discovered in the southern part of Australia, and the California scenes of 1848 and 1849 were re-enacted in that remote part of the world in 1852 and 1853.

The whole amount of gold dug from the discovery of this country to the California discovery was twenty-eight hundred million dollars; the quantity added in the ten years from 1843 to 1853 was six hundred million dollars; and the whole of the addition since 1848 to the present time is three thousand three hundred millions, — nearly as much as was added during the fifteen hundred years from the beginning of the Christian era to the discovery of America.

An Indian, soon after the arrival of the Spaniards, chasing a deer up the slope of a mountain in Peru, laid hold of a bush to aid his climbing; the bush started from the earth, and disclosed a mass of shining and precious metal beneath the root, enough to enrich him and all his tribe, and to fire the cupidity of nations parted from them by great oceans. A few other fortunate accidents, similar to this, has made it the waking dream of millions that, some time, in some ravine, or on a hill-side, or in the recesses of a cave, or among the sands of a mountain stream, chance would fling before them a nugget, or a pile of glittering sand, that would lift them at a giddy bound from the narrowness of a cottage to the splendors of a palace. While the principles of metallurgy were unknown, the boor and the sage were alike uncertain whether the earth beneath their house, or the soil of their garden, might not contain an abundance of this much-coveted, glowing sand. It is .ow known that the quantity of gold in the heart of certain mountains, and in the sands of certain streams, is enormous — as great as was ever pictured in the dreams of distempered fancy; but it is also known that the rocks hold it in so firm a grip, the sands contain it in such hopeless combination with worthless matter, that, as a rule, it will require more than a dollar's worth of labor to realize and refine a dollar's worth of metal.

The business of obtaining gold has been stripped of most of its delusions, the glamour of romance has been dispelled from the magic word, and the science of it, instead of being occult and marvellous, has its difficulties and its stubborn problems; but our age is advancing in the mastery of them by the same steps and by the activity of the same faculties that are pushing us along a steadily ascending grade in our manufactures of iron, and wood, and cop-

per, and tin, in the giant industries of cotton, of coal, and of wool.

In many parts of the country it is possible to find great masses of rock that hold a little gold, and millions of cubic yards of earth from which a few cents' worth of gold can be washed. If a silver dime is laid on the common school atlas of the United States, over the town of Charlotteville, in North Carolina, it will be found to cover the region from which the greater part of American gold was obtained previous to the wonderful disclosures in California in 1848. The Carolina mines are similar to those of California, the only difference being in richness.

For some years the average earnings of the California gold washer were twenty dollars a day; but it is doubtful whether all the gold washers of Carolina would not be richer than they are to-day if some solid industry had returned them fifty cents as a certainty for every twelve hours of hard work over those delusive banks of reddish earth.

No savant can explain the origin and nature of gold. It is a simple substance, which, from unknown sources in the bowels of this planet, has been injected in layers or veins into a certain class of ancient and igneous rocks. Wide geological observation has proved that it would be utterly futile to look for gold in red sandstone, or in lime rock, or in the alluvial of great rivers, as the Mississippi and the Nile. A gold region is generally, and in this country always, a country where there is a lofty range of mountains, consisting of a central core of granite flanked by metamorphic slates. The gold has been injected, generally in close connection with quartz, into these beds of micaceous and hornblende slate. As these beds have been cut by streams, and as the torrents of a steep and rocky country are violent, and roll along masses of rock and gravel, the sands which are found in the beds of such streams are golden sands. By far the greater part of the gold of commerce has been gathered, grain by grain, in the beds of streams, and this mode of obtaining it is called placer, or wash-mining. When the operator or prospecter follows up the bed of the stream, and finds the veins that have been cut by the mountain torrent, and attacks them with gunpowder and pick, crushing the auriferous rock and separating the precious metal, — this is called quartz mining.

The history of gold mining in California is a record of processes growing continually more and more elaborate and expensive. Since

1848, from 1848 to 1868, eight hundred and fifty million dollars' worth of gold was taken from the auriferous sand of the California streams, or by crushing the quartz in her mountain veins. Nine tenths of this amount were obtained by the various processes of placer, or wash-mining, which we propose quite minutely to describe.

The rudest implement, and the one quite generally used for prospecting purposes, is the horn spoon. It is made by sawing a large horn in halves lengthwise, and scraping the section so as to form a sort of curved spoon, which is about two inches deep, from two to three inches broad, and about eight inches long. It holds but two or three pounds of earth, but long practice renders the miner so skilful in the use of it, that he can extract the gold from a spoonful of auriferous earth with a facility that is quite wonderful.

Another simple process is panning. The pan used by a gold digger is of about the size of an ordinary milk-pan, and is pressed into shape from sheet iron. It is half filled with the sand or earth, water is added, the contents are stirred and poured off, until most of the clay and fine dirt is thrown out. When the contents are reduced to a mass of comparatively clear sand, the miner holds the pan in a slanting direction and gives it a peculiar twirl, by which the top, and only the top, of the sand is flirted out. This process is continued until only a pinch of the shining sand is left in the lower angle of the pan.

In many diggings there will be nuggets of considerable size, many as large as a pin-head, and some as big as a squirrel shot, to be found at the bottom of a panful of earth. But generally the result of the first washing, as much perhaps as would fill a lady's thimble, is placed by itself, and afterwards a quantity of these pannings is washed again with great care.

When the California gold was first discovered, some of the earth would pan out fifty cents' worth at each handling. This process is kept up day after day, and week after week, the results varying immensely, according to the richness of the sand. The hopes of the miner are sometimes stimulated by taking out a dollar's worth at a washing ; yet he often keeps on with hopeful but wearisome industry, washing dirt that does not give a cent to the panful.

But a miner with any enterprise will soon contrive some more effectual way of handling pay dirt, and a very natural and useful device is the cradle. This consists of a half cylinder, usually made by splitting a large tree and carefully digging out the middle

wood till only the surface shell remains. Several ribs or notches are left on the inside, like the hollows in a wash-board, the use of which is to catch the particles of gold as they are washed down from the gravel. The cradle is mounted on rockers, or supports, with a facing of iron strapped on the upper edge, and is then set at a gentle incline of about six inches in ten feet. A part of the stream is conducted by spouts, so as to pour into the upper end of the cradle, and the quantity of water used is adjusted to the character of the dirt and the length and inclination of the cradle. A shovelful of the earth is thrown under the fall of water, and the rocking begins. The clay is first dissolved, and the first running off of water is muddy. The sand lodges in the ridges, and the water running over it washes the top away and carries it down to the mud at the lower end of the cradle, forming what is called "tailings."

In some diggings the washing has been so careless that these tailings are still rich, and will pay for several successive washings. Two miners generally work as partners, one rocking the cradle and throwing out the gravel stones, and the other throwing in the dirt. If the gold is coarse, most of it can be picked up from the crevices. But usually quicksilver is used as an amalgamator. A little is poured into each depression, and as the rocking motion is continued, the gold is gathered up, grain by grain, till the quicksilver becomes somewhat stiff and pasty, which is an indication that it cannot take up much more. These little pellets of amalgam, or quicksilver and gold in combination, are then taken up with a spoon and stored in a buckskin bag; fresh quicksilver is poured into the cradle, and the work goes on. At night the collection of amalgam is squeezed through chamois skin. This strains the quicksilver out as lively as ever for further use, and the dust is divided between the two miners. This dust they can exchange for food or for coined gold pieces, a certain regular discount being made for impurities.

When a stream or section of country is found to be rich in pay dirt, several miners put their earnings together and put up a sluice, which is a far more effectual way of washing out gold than any that have been described. A sluice consists of a series of square wooden troughs that taper a little towards the lower end, so that one will fit into the other. They are made about twelve feet long, a foot and a half wide, and a foot high, and the bottom is paved with wooden blocks, set next each other like wooden street pave-

GOLD WASHING IN THE CALIFORNIA MINES.

AUSTIN, NEVADA, A WESTERN MINING TOWN.

ments, with a little quicksilver at the bottom of the interstices. The sluice has a downward pitch of from ten inches to a foot and a half for each box of twelve feet in length, according to the quality of the dirt thrown into it. The spaces between the blocks, or "riffles," as they are called, are soon filled with sand as the washing begins, but the fine particles of gold are caught in the sand, and slowly work their way to the bottom, where they are retained and taken up by the mercury, while the pebbles are swept along by the current, and carried out at the tailings. The sluice is, in fact, an artificial stream, with various irregularities in its bottom, so contrived as to arrest the gold, the nuggets being detained by the larger cracks, and the fine dust being caught in the mercury.

The quantity of water required varies with the coarseness of the dirt from as much as pours through a square orifice three by four inches, to the discharge through a square four by five inches. The quantity of water to be used by each sluice company is regulated by district mining laws. Sluices vary greatly in length, some consisting of only three or four boxes, and others extending many thousand feet.

The washing, once begun, goes on for many days, and sometimes, where the dirt is rich, there are double gangs of men, and the work is not interrupted at nightfall. It is found that most of the free gold and the nuggets are lodged in some part of the sluice; but many of the finer particles go out with the tailings, and the art of managing these fine particles so as to save them without great loss of time and labor requires careful study by our metallurgists. After a large quantity of dirt has been washed in the sluice, the miner shuts off his water, and takes a day for cleaning up. The first blocks or riffles at the head of the sluice are taken up, and the rich sand carefully brushed down from their sides. When a number of boxes have been cleared in this way, a little water is let in, and the washing is conducted very carefully. The amalgam is taken up in little scoops made for the purpose, while the nuggets may be picked up in the fingers. In a rich mining district, where the sluice work has been carefully conducted, the cleaning-up day is one of considerable excitement, as many thousand dollars are frequently found nestled between the wet blocks and absorbed in the little puddles of quicksilver. After straining the amalgam through the chamois, it is sometimes retorted on the spot, but more frequently sold to skilled operators, it being understood that about forty per cent. of the amalgam is gold. The

quicksilver is expelled by roasting in a close retort, so contrived that the evaporated quicksilver may be condensed and used over again. At present a very large proportion of the wash mining of California is conducted by the sluice process.

With it is connected hydraulic mining, by which immense masses of earth are torn down and thrown into sluices by the action of water alone. All the region above the mining lands of California abounds in lakes and mountain streams, so that a ditch or sluice will bring the water to a reservoir a hundred or two hundred feet above the bank of earth to be washed. It comes down from the reservoir in very strong iron pipes, to the bottom of which a hose, made of the strongest canvas, and bound about with cords, is attached. A stream of water is made to play against the bank with a force like that seen in the action of the strongest steam fire engines. The water, the mud, and the boulders thus torn from the side of the hill are conveyed down a long sluice, the height and width of which correspond to the quantity of water used. Sometimes fifty thousand cubic feet of water per hour are hurled against a bank or hill-side, and made to wash the most of it down the sluice. Under the steady action of this immense power the earth is softened, broken down, and washed away, at a rate that is amazing. There is generally arranged a precipitous fall in some part of the sluice, so that the gravel which has been cemented together by the action of iron in the water is crushed and disintegrated, thus releasing quantities of gold which it would be very expensive and difficult to reach by any other process.

Quartz Mining.

There is a large amount of capital invested and industry engaged in washing gold from sand and concrete ; but this branch of mining is coarse and primitive compared with operations the object of which is to crush the rock in which gold occurs, and extract the precious metal from the pulverized rock. As much the greater part of the gold thus extracted is separated from close connection with quartz rock, this branch of the industry is called quartz mining.

The prospecting miner becomes an expert in the appearance and nature of quartz rock in California. The presumption is always in favor of a vein of quartz that it has more or less of gold in it. He detaches portions of the rock, explores the side of the hill or

mountain, so as to learn its dip, or direction, and its width. It seldom occurs that the poor, prospecting miner is made rich by his discovery. He records his lode or claim, and, if his wants are pressing, will sell it for a small sum in hard money. If he discovers a thrifty disposition at the same time that he finds the shining ore in the rock, he will not part with his claim, but seek to unite capital with it, so as to erect a stamping mill. If the rock is found to pay well after a few tons have been crushed, and the lode appears to be quite wide, and other indications are flattering, but little hesitation will appear on the part of capitalists. No great outlay is required at first in the extraction of gold-bearing quartz.

When the vein is strong, and great confidence is felt, a tunnel is carried into the side of the hill, a few hundred feet below the outcrop, and as soon as the vein is reached and found to be valuable, a rude railway is laid in the bottom of the tunnel, and the auriferous rock is taken out to the dump, and the mill is erected as near to this as the nature of the country will admit.

A stamping mill consists of an engine of sufficient power to work a number of strong iron pestles, or upright bars, lifting them about a foot high, and letting their great weight come down with a crushing power upon the fragments of rock laid beneath. The chief parts of it are the boiler and engine, the stamps, and some apparatus for gleaning out the gold from the quantities of fine rock made by the action of the stamps. At first, until the value of the mine is well known, an eight or ten stamp mill is considered all that prudence dictates. The power of the engine is applied to a series of cams, which lift these stamps to the desired height. The stamp consists of four parts — the stem, or long cylindrical shaft, held in position by grooves; the tappet, or arrangement for lifting it by a cam; the head, and the shoe. The head is considerably larger than the stem, and at the lower end has a hole into which the shoe is slipped. This shoe is liable to be broken or worn out by the work it has to do, and must be renewed. The mortar, where the crushing is done, is a very strong iron box, with cavities in the bottom for the dies or anvils where the weight of the blow falls. This mortar, as well as the dies, rests upon solid timbers, well bedded in the earth.

Each stamp can pulverize from one to three tons of rock in twenty-four hours, the speed being about sixty blows in a minute, or a stroke every second. A stream of water pours into the mor-

tar, and as the work advances, and the rock becomes dust, it is taken up by the water and carried out through a fine iron screen. This crushed ore and water, or pulp, as it is called, is allowed to flow away in a shallow sluice, and there are several methods by which the gold in it is extracted.

The blanket method is much used in those parts of California which produce the most gold. A coarse, woollen blanket is spread in the bottom of the sluice, and the fine particles of gold are caught in the meshes. These are soon filled with the gold and the pulp, and are then taken up and rinsed in a large tub, the gold settling in the mud at the bottom of the tub. Below the blankets are riffles (such as are used in common sand washing), with mercury in them to arrest the free gold that has escaped the meshes of the blankets; but a great deal of gold passes on in the form of sulphurets, which can be reduced by roasting, or the chlorine process. Mercury is also placed in the battery or mortar.

Thus, in stamp mining as now carried on at Grass Valley and other mining districts of California, the gold is saved in three parts of the process: —

1. The quicksilver in the battery arrests much of it, and in some quartz there are lumps or nuggets of considerable size, which can be picked up from the bottom of the battery when the stamps are stopped for cleaning up.

2. The blanket washings are treated with mercury, and much gold collected.

3. The sulphurets, or dark, shining sands that collect at the tailings, may show little free gold, but by roasting, or other treatment that will expel the sulphur, the gold blended with it may be set free.

By far the best method of treating the black sulphuret is by the chlorine process, or the Plattner process, and it may be understood in its outline by the following description: The dark, shining sands are placed in an oven where a roasting heat is kept up for twenty-four hours. For about ten hours the effect of this roasting is to expel the sulphur. During the last half of the process the heat is increased, and the metal becomes an oxide, and is blended with sulphate of lead. Salt is sometimes added in the last stage of the roasting with excellent effect, especially when there is some lime or magnesia in the ore. When the ore cools it is made damp and thrown into a vat that has two bottoms, the upper one being pierced with many holes. The inside of this vat is made gas-tight

by a thick coating of bitumen. Chlorine gas is introduced both above and below the ore, and the effect of it is to take up the gold and convert it to chloride of gold. After holding the gas in close contact with the roasted ore for twelve or eighteen hours, water is introduced in a small stream, and as it trickles through the mass, it is carefully saved, for this water is a solution of chloride of gold, and realizes the dream of the old alchemists, who hoped for wondrous effects if they could but make liquid gold. If a combination of sulphur and iron is thrown into this liquid, the gold is thrown to the bottom in the form of a very fine powder. After the vat has settled, the water above the powder is slowly drawn off, and the powdered gold is carefully dried on broad sheets of paper. It is believed that ninety per cent. of the gold is saved by this process, and at a cost of about twenty dollars per ton of ore.

There are about five hundred quartz mills in California, and the average number of stamps in each is ten. In the Grass Valley mining district, the best in the state for quartz mining in a radius of four miles, Ross Browne says three and a half millions of gold are produced annually. This is an average yield of seventeen hundred dollars to each person at work. One mine, the North Star, one of the best gold mines in the world, has yielded six hundred thousand dollars in net profits, and the profits are now going on at the rate of from ten thousand dollars to twelve thousand dollars per month. During the twelve years from 1849 to 1861 California gave us a little over fifty millions in gold annually. Since 1862 the product has slowly declined, and is now between twenty-five and thirty millions a year, and one third of this is the product of stamp mills and quartz mining; the other fifteen or twenty millions is washed from sand and gravel by the different contrivances we have described.

The California of to-day, compared with the community of excited gold hunters that washed out sixty-five millions of this metal in 1853, illustrates the contrast between a mining population and a community devoted to general industry. The wheat crop of this year is about equal in value to the gold product. Washing sand and crushing ore is but one, and that comparatively a secondary industry. Yet the average prosperity of the state is far higher than in those wild and romantic days when every rill in the state was believed to "flow down over golden sands."

It is doubtful whether the whole of the twenty-five or thirty

millions which the state may yield this year, if divided equally among all who work in gold mines and washings, would give each worker a dollar a day.

The extreme malleability of gold has made it a prominent metal in the fine, and also in the useful, arts. But the quantity consumed or lost is not large compared with the amount produced. It is calculated that from one to three millions annually are used in ornaments, in gilding, in lettering and edging, in dentistry, and in plate. There appears to be a greater quantity consumed in these industries; but a little of this remarkable metal produces wonderful effects. A cubic inch of it can be hammered so as to cover a space thirty-five feet wide and one hundred feet long. And twenty of our twenty-dollar gold pieces can be drawn into a wire that would surround the globe.

Modern developments in chemistry have given the arts several substances of remarkable value and beauty, as, for instance, platina and vulcanized gutta percha; but for beauty of appearance, as an unscientific standard of monetary value, for weight, ductility, and power of resisting acids and decay, gold is still the king metal.

WASHING FOR GOLD.

MERCURY, OR QUICKSILVER.

THE DERIVATION OF THE NAME QUICKSILVER. — THE KNOWLEDGE OF QUICKSILVER IN ANTIQUITY. — THE MANNER IN WHICH MERCURY IS FOUND IN NATURE. — THE CHIEF SUPPLIES OF IT. — THE PROBABLE MANNER IN WHICH IT WAS DEPOSITED. — THE MINES OF MERCURY IN EUROPE. — THOSE IN AMERICA. — THE PROCESS OF OBTAINING IT. — THE USES TO WHICH IT IS APPLIED.

MERCURY, or quicksilver, is a metal, which is fluid at the temperature generally prevailing on the surface of the earth. From hence its name *quicksilver*, which is a translation of the name *argentum vivum*, live silver, given it by the Latins. The word *quick*, in its old signification, means alive, as we see in the text "the quick and the dead," meaning those who are alive and those who are dead. At a temperature of 40° below zero mercury assumes a solid form, crystallizing into regular octahedrons, and becoming malleable, contracting in bulk, and obtaining a greater specific gravity. It boils at 662°, passing off then in the form of a transparent and invisible vapor, the density of which is more than six times greater than that of air.

To the oldest nations of antiquity the use of mercury was unknown, nor had they arrived at a knowledge of the process for obtaining it from the compounds with which it is usually found in a state of nature. The chief source from which the modern world obtains its supply of mercury is from the deposits of cinnabar, which is a native sulphuret of mercury, consisting of one atom of mercury and one of sulphur, or by proportion, 86.2 of the first to 13.8 of the second. It also occurs in several other natural combinations with other substances, but not in sufficient quantities to justify its preparation as an industry.

In most of the natural deposits of mercurial combinations, pure mercury is found deposited in small globules, as might be expected from the volatile character of the metal. From a scientific exam-

ination of the deposits of mercury, it is evident that it has been absorbed into their mass while in a state of vapor, impregnating them with metallic matter in every direction. There are instances which show that the metal must have been sublimed from below, during the most recent geological epochs, since it is found in considerable quantities, in the metallic state, associated with the superficial deposits, even with the alluvium itself. The geological formation in which the ores of mercury are found range from the lowest to the highest in the scale; but the principal mines are worked in the silurian and carboniferous strata. When the mercurial ores are found in the older metamorphic rocks, they seem to exist either in true veins, or in connection with them; but the greater proportion of the ore belongs to the class of contact deposits.

In Europe, the chief mines of mercurial ores are found in Spain and in Austria, those of Spain being the most important. These mines, known as the mines of Almaden, are situated in the province of La Mancha, near the frontier of Estremadura. The chief workings are near Almaden, but the ores are found in a wide belt running in an easterly and westerly direction, extending from the town of Chillon to Almadenejos. These mines have been worked longer and more uninterruptedly, probably, than any others in the world. They were worked by the Greeks, according to Pliny, at least seven hundred years before the Christian era, for the purpose of obtaining the cinnabar, which was made into vermilion; and the same author estimates the annual product of these mines to the Romans at one hundred thousand pounds. Since that time these mines have been worked almost continually, and yet it is stated by competent authority that they will be able to furnish their present supply for an indefinite time. They are now excavated only about one thousand feet. The ore in the principal working lies in the main vein, about forty to fifty feet thick, all of which is rich enough to pay for working, it yielding no purely barren rock. The average yield of the ore is ten per cent., but much of the metal is lost from the imperfect methods of extracting it. The present yield is about two and a half millions of pounds a year. Formerly these mines were worked by the condemned criminals of the state, but now the workmen are hired.

The imperfect process in use for the extraction of the metal from the ore, leading as it does to the escape of the mercurial vapors, causes a variety of diseases in the workmen, and limits their lives

to only a few years. These mines, being the property of the government, are leased to contractors at a rent, or royalty, on the product. Of late years, they have been leased by the Rothschilds of Europe; and as the government has at every renewal of the contract raised their price, the price of mercury since 1839 has been almost doubled. It was only by the discovery of the mines in California that the indefinite extortion of the Spanish government has been checked.

The next important mines of mercury in Europe are those of Austria. These are situated at Idria, in Carinthia, and have been worked for several hundred years. The ore is chiefly the sulphuret, with some native mercury. It is contained in a black compact limestone, associated with shales, in which are found the fossils of the Jura limestone age. The metal, from its intimate combination with the shales, has evidently been deposited in the form of a metallic vapor.

In America, both Peru and Mexico contain mines of mercurial ore. The native Indians of Peru worked the mines before the arrival of the Spaniards. It is, however, most probable that they worked them only for the purpose of obtaining the material of their paints. The most important deposits in Peru are those in the province of Huancavelica; the presence of mercury has been proved in forty-one different localities in this province. The chief mine is, however, that of Santa Barbara, which is still called by the people "the Great Mine." It has been worked since 1566, but so negligently has the work been done, that much of it has fallen in. On one occasion two hundred workmen were killed by such an occurrence.

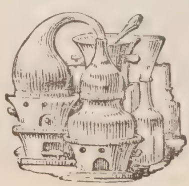
In Mexico there are deposits of mercurial ore in several places. Humboldt mentions the following as the most important: Gigante, near Guanaxuato; Rincon de Centeno, near Queretaro; Durasno; Sierra de Pinos, and other places in the department of San Luis Potosi; Melilla, in that of Zacatecas; and El Doctor, in that of Queretaro. The ores are found either in beds in the secondary strata, or as veins which traverse the porphyritic trappean rocks.

At Durasno, cinnabar, mixed with many globules of native metal, forms a horizontal bed resting on the porphyry, and covered by beds of shaly clay, containing fossil wood and coal. The excavations are only pits a few feet in depth. Though several hundred quintals, weighing one hundred pounds each, were at one time taken from it, yet this appears to have been only a limited

deposit. At San Juan de la Chica the cinnabar vein is from seven to twenty feet in thickness, yielding an ore which is rich, but not abundant.

In the United States no deposits of mercurial ore have as yet been discovered east of the Mississippi River. In California, however, the existence of mineral deposits of mercurial ore was known before the discovery of gold, and in 1845 a company was formed to work an important deposit of cinnabar, at New Almaden, in one of the side valleys of the San José. The ore here is found in connection with sedimentary strata, composed of beds of argillaceous shales alternating with layers of flint, tilted up at nearly a right angle, and much bent. They were considered by W. P. Blake, who visited them, to belong to the silurian age.

The Indians had used the ore as a material for their paint, and had made, in search of it, an excavation about sixty feet into the mountain. The war put a stop to the prosecution of the work, but in 1850 a new company re-commenced operations, and continued them until enjoined by the United States, as a preparatory step towards the settlement of the question of title to the property. The average yield of the ore is about thirty per cent. The mines are now worked, and the yield is large. From this and the other mines now worked in California, the yearly yield is estimated at about two millions of pounds, being over one third of the production of the world. The uses of mercury in the arts are various, the chief one being its use in extracting gold in gold mining. The one next in importance is, probably, its use as an amalgam with tin, in silvering the backs of mirrors. It is also used considerably in the manufacture of philosophical instruments, in barometers and thermometers, the quality by which it expands and contracts regularly through a great range of difference in temperature making it most valuable for this purpose. For making vermilion paint, and as a medicine, in the mixture called calomel, considerable quantities are also used. Besides these uses, mercury enters into many of the chemical compounds which have come into demand in the varied industry of modern times.



MIRRORS.

THE FIRST SUGGESTION FOR MIRRORS. — MISTRANSLATIONS IN THE BIBLE. — THE LOVE OF EASTERN WOMEN FOR MIRRORS. — MIRRORS IN ANTIQUITY. — MIRRORS OF STONE IN USE BY THE NATIVE PERUVIANS. — MIRRORS OF SILVER. — MIRRORS AMONG THE ROMANS. — MASCULINE SATIRES UPON WOMEN'S LOVE OF MIRRORS. — THE FIRST USE OF MIRRORS OF GLASS. — THE METHOD OF SILVERING THEM. — MIRRORS IN THE UNITED STATES.

Mirrors may have been suggested by the glassy surface of still water; but there are reasons to believe that mirrors were made as soon as men began to exert their skill in metals and stones. Any solid body, capable of receiving a polished surface, could be used for such a purpose. In the Book of *Job* occurs the following passage: "Hast thou with him spread out the sky, which is strong, and as a *molten looking-glass?*" The word rendered "looking-glass" should have been rendered *mirror*. It is said also in the Book of *Exodus* that Moses "made the laver of brass of the looking-glasses" (mirrors) "of the women assembled at the door of the tabernacle of the congregation." As these mirrors were formed into a *brazen* laver, the mirrors were of that material. In *Ecclesiasticus* it is said, "Thou shalt be unto him as if thou hadst wiped a looking-glass" (mirror), "and thou shalt know that his *rust* hath not been altogether wiped away." There can be no doubt that metallic mirrors are referred to in all these places. The women assembled at the door of the tabernacle for worship are supposed to have been in full dress, so that it was necessary for them to have their looking-glasses (mirrors), according to the custom of the Egyptians. They were voluntarily presented to Moses, or delivered up on a requisition, for the purpose of making out of them one of the utensils of the tabernacle. It may have been a blow struck by the Hebrew leader at the vanity of the women. In later times, the prophet Isaiah, speaking of the extravagance of female dress, enumerates, among other things, rings, nose-jewels, wimples, crisping-pins, and *glasses*. It is probable that their excessive vanity was evinced by carrying small mirrors, that

they might at any time examine and adjust their dresses. This appears to have been a peculiarity of women in Eastern countries from time immemorial. The Moorish women in Barbary are said to be so fond of their ornaments, and particularly of their looking-glasses, which they hang about their breasts, that they will not lay them aside even when, after the drudgery of the day, they are obliged to go two or three miles with a pitcher or a goat-skin to fetch water.

As articles of the toilet, mirrors were held in high esteem, since, with other precious things, they were deposited with the dead in the tombs and places of burial of the ancient nations. In what are called the Christian catacombs of ancient Rome mirrors have been found similar to those found in the tombs of Greeks, Etruscans, and Romans. Boldetti speaks of some found in the tombs of children in the catacomb of St. Calistus, which appeared to be made of a mixture of bronze and lead, or tin, similar to those made in Brundusium, which Pliny speaks of as the most celebrated and the most valued. They were sometimes made of a particular stone, which is supposed to have been a kind of vitrified lava. The houses of the rich were sometimes ornamented with polished slabs inserted in the walls of wainscoted apartments. Domitian, when he suspected that plots were formed against him, caused a gallery, in which he used to walk, to be lined with a kind of polished stone, which by its reflection showed everything that was done behind his back. The Spaniards, when they came to America, found mirrors made of a substance called the Inca's stone, because the same material was used for ornaments by the Incas, or princes of Peru. It appears to have been a compact pyrites, susceptible of a fine polish, and calculated to form mirrors apparently superior to any of stone which the ancient nations of Europe or Asia seem to have possessed. The Americans had also at the same time mirrors of silver, copper, and brass. In Egypt mirrors were made of mixed metal, chiefly of copper, highly polished. Some have been discovered at Thebes, the lustre of which has been partially restored, though they had been buried in the earth for many centuries. The greater part of the ancient mirrors were made of silver, not on account of costliness and magnificence, but because silver was the best adapted and most durable of all the then known unmixed metals for such uses.

In the Roman law, when silver plate is mentioned under the head of heirship and succession, silver mirrors are rarely omitted.

Seneca and other writers of his time, speaking against luxury, ridicule the extravagance of the age, in which every young woman must have a silver mirror. These mirrors were round or oval, with handles of wood, stone, or metal, according to the taste of the owner, not differing much in form from the hand-mirrors now in use.

At a later period the extravagance of the times was censured by Jean des Caures, an old French moralist, who, declaiming against the fashions of his day, notices one, of the ladies carrying mirrors fixed to their waists, which seemed to employ their eyes in perpetual activity. From this *mode* will result, according to honest Des Caures, their eternal damnation. "Alas!" he says, "in what an age do we live, to see such depravity as we see, that induces them even to bring into church these *scandalous mirrors hanging about their waist!* Let all histories — divine, human, and profane — be consulted, never will it be found that these objects of vanity were ever thus brought into public by the most meretricious of the sex. It is true, at present none but the ladies of the court venture to wear them; but long it will not be before *every citizen's daughter* and *every female servant* will wear them."

A satire on the same subject appeared in a book entitled "*Life and Adventures of Miss Robinson Crusoe.*" Wrecked, as the famous *Mr.* R. Crusoe was, she plundered the ship, and transported all things valued by a woman to her lonely island. About to leave the ship with a loaded raft, she says, "The thought flashed upon me, and, as I may say, with its brightness illuminated the very depths of my being, when I remembered that I had no looking-glass. A woman, nursed in the lap and dandled on the knees of luxury without a looking-glass! Imagine it, dwell upon it! Is it possible for Fate, in its worst malignity, more cruelly to punish her? When at home, with every blessing about me, I thought nothing of the chief delight, the happiness, of sitting two or three hours before my mirror, trying here a patch, and there a patch; now making pretty experiments with my hair for more certain killing." She secured a looking-glass. "Very thick and very violent were the beatings of my woman's heart as I brought the mirror over the ship's side. No words, though bright as rainbows, can paint my feelings when I saw the glass safely lowered among my other goods. I sank upon the deck, and grateful tears ran like rain-drops on cottage casements, down my cheeks."

Chrysostom, in the latter part of the fourth century, speaking

in a sermon of the extravagance of the women, says, "The maïd-servants must be continually importuning the silversmith to know whether their lady's mirror be yet ready."

It is supposed that the largest mirrors in use by the ancients were often made of polished plates of silver; and some were so large as to reflect the whole person. Such, doubtless, was the one used by Demosthenes. Plutarch says he had a looking-glass (mirror) in his house, before which he used to declaim, and adjust all his motions.

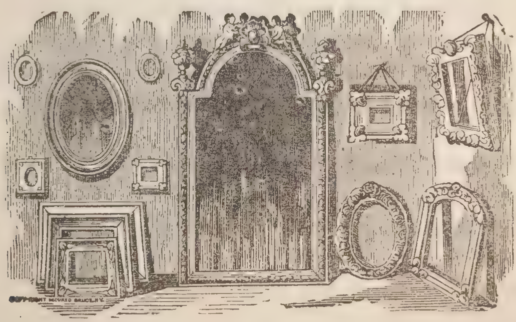
But the point of most masculine satires against the inordinate feminine love of mirrors would be destroyed, should we quote instances enough to show that the use of mirrors is as common among men as among women. Let us therefore pass over with judicious silence this branch of the subject.

Metallic mirrors were generally used until the thirteenth century. The first mention of glass mirrors, covered on the back with tin or lead, is made by Johannes Peckham, an English Franciscan monk. In the year 1279 he wrote a treatise on optics, in which he speaks of mirrors made of iron, steel, and polished marble; also of glass mirrors, which were covered on the back with lead, and that no image was reflected when the lead was scraped off. "That this invention cannot be much older we have reason to conclude, because glass mirrors were extremely scarce in France even in the fourteenth century, while mirrors of metal were in common use; and we are told that the mirror of Anne de Bretagne, consort of Louis XII., was of the latter kind. Metal mirrors were also made and used in Persia and the East, where, indeed, ancient usages continued longest, and glass mirrors were not known there till the commencement of the European trade with these remote regions. Metallic mirrors are still preferred in those countries, because they are not so liable to break, and can be preserved better in a dry, hot climate than the amalgam of glass mirrors."

Respecting the progress of this art, it appears that at first melted lead, or perhaps tin, was poured over the glass plate while yet hot, as it came from the furnace. This process agrees with that which, at an early period, was employed in Nuremberg for making convex mirrors. By means of a pipe, a metallic mixture was blown into a hollow ball of glass while hot, completely coating the inner surface. When the glass became cool, it was cut up into small, round mirrors. Early in the sixteenth century the Venetians made glass mirrors by coating the surface with an amalgam of tin

and quicksilver. This is claimed as an Italian invention; and till the end of the seventeenth century their mirrors were sold all over Europe and in the East and West Indies. The discovery in France that glass, like metal, could be cast into larger plates than had been prepared before by blowing and rolling, marked a decided improvement in the manufacture of mirrors. All but the commonest mirrors are now made of plate-glass; and the process of coating them does not differ very essentially from the method adopted by the Venetians three hundred years ago. This process, as described by an eye-witness, consisted in spreading tin foil smoothly on a plane surface; quicksilver was then poured over it, and rubbed into it with the hand, or a hare's foot; and when the tin was saturated, it was covered with paper. The glass, wiped very clean, was then laid upon it, and the paper withdrawn. Weights were then placed on the glass, which remained till the excess of quicksilver drained off. A new method of silvering glass was invented by a Mr. Drayton in 1843. It consisted in depositing silver from a solution, so that the precipitate will adhere to the glass, without the latter having been coated with metallic or other substances.

Large mirrors are made in the United States. The glass plates are generally imported, and the coating only is done here. The old method of coating with tin foil and quicksilver is usually adopted in preference to other more modern modes, as the former is more durable and secures greater whiteness and brilliancy of reflection.



SILK DRESS-GOODS.

THE DERIVATION OF THE WORD "SILK." — THE ANTIQUITY OF SILK CULTURE. — THE REFERENCES IN THE BIBLE TO SILK. — USE OF SILK AMONG THE ROMANS. — THEIR KNOWLEDGE OF ITS CULTURE. — THE INTRODUCTION OF SILK-CULTURE INTO GREECE. — INTO ITALY. — INTO FRANCE. — INTO THIS COUNTRY. — SPECIMENS OF SILK RAISED HERE DURING THE COLONIAL PERIOD. — FLUCTUATIONS IN THE BUSINESS. — THE MORUS MULTICAULIS SPECULATION. — CONGRESSIONAL REPORTS CONCERNING THE CULTURE OF SILK. — THE SUCCESSFUL ESTABLISHMENT OF THIS INDUSTRY. — THE MANUFACTURE OF SILK DRESS-GOODS. — THE INCREASED CONSUMPTION OF SILK. — THE INCREASED SUPPLY. — NEW MEANS OF PRODUCTION SUGGESTED. — THE PROBABLE FUTURE OF THE BUSINESS.

THE manufacture of silk as an article of apparel dates from a very early period of the world's history. Our very word "silk" is derived from the Greek *seres*, the name given to the people of the East, the Chinese, who manufactured all the silk used at this early period. From the Greek the Latins obtained their term *sericus*, "silken," and from them the term spread to the different nations of modern Europe, appearing in Anglo-Saxon as *scolc*, in Icelandic as *silki*, in Danish as *silke*, in French as *soie*, and so on.

The various references in the Bible to silk are, with the exception of that in Revelation, believed by the best authorities not to refer to silk, but to be mistranslations, since it is quite evident that the Hebrews in early times were not acquainted with this texture. In their literature the Chinese have treatises describing the processes of silk culture and its manufacture, for which they claim an antiquity of four thousand years, and which were unquestionably written many ages ago.

Among the Romans, dresses of silk came to be considered articles of disreputable luxury; and during the reign of the Emperor Tiberius, an edict was passed by the Senate forbidding men from wearing them, since the effeminacy introduced by the increased use of this material was thought to threaten the most disastrous results for the state. Aurelian also used his influence against its use, refusing to give his wife a silk robe. During the reigns of the luxurious emperors, such as

Caligula and Elagabalus, its use was, however, encouraged by the example of the rulers themselves, who adopted its wear. The prices of silk textures in these times was so large at Rome, that, in the second century after Christ, the Emperor Marcus Aurelius replenished his treasury by the sale of the shawls and scarfs which had accumulated in the royal wardrobe during the reigns of his predecessors.

Marcus Aurelius also sent an embassy to China with the view of opening a direct trade between Rome and that country for the supplies of silk consumed by the Roman Empire. Up to this time the supply of silk had been furnished to Rome through the agency of the Persian caravans, and the expense of this intermediate trade was one of the chief causes of the excessive price of silks to the Romans. This attempt was, however, not successful, and the Persians retained their monopoly of the silk-trade in Europe for nearly five centuries longer, until the culture of silk was imported into Europe.

That silk was the product of a worm was known to Aristotle and to Pliny, but many Roman writers, in speaking of it, describe it as a sort of down produced by trees. In the reign of Justinian, two Persian monks, who had spent years in China acquiring a practical knowledge of the processes of silk-culture, brought to Byzantium silkworm eggs concealed in a hollow reed of bamboo, and commenced the culture of silk in Europe. The business increased rapidly, and was soon understood in Greece, which for a long time held the leading position in Europe in this industry. In the twelfth century it was established in Sicily, on the overthrow of the Byzantian Empire, and up to the sixteenth century Italy remained the chief country in Europe for the production of dress-silks.

By the agency of Francis I., while the French occupied Milan in 1521, workmen were sent from Italy into France, and in the southern part of that country silk-culture soon obtained a permanent footing. Frequent attempts were made by James I. of England to inaugurate the culture and manufacture of silk into England, but without success. On the settlement of Virginia, James strongly recommended the introduction of silk-culture in the Colony, and sent supplies of silkworm eggs from his private stores. Nor were attempts to inaugurate the culture of silk confined only to Virginia, but every one of the Colonies became interested in the matter, and more or less silk was raised in almost every one of them, from Massachusetts to Georgia. Most of the colonial governments stimulated the industry by bounties and other encouragements, and in some of the Colonies the business appeared

to have been raised to a permanent footing. President Styles, of Yale College, was most earnest and persistent in attempting to establish the culture in Connecticut; and in the library of the college there are preserved the records he kept for a period of forty years of his various experiments and experiences in prosecuting this industry. In 1788, President Styles, at the Commencement of the college, wore a silk gown made from material raised and woven in the State.

Various specimens of the silk made in different parts of the country are still in existence in the possession of the descendants of those who were interested in its culture. One of these is an entire dress, which was recently in possession of Mrs. Horry of Charleston, S. C., a descendant of Mrs. Pinckney, the mother of the Revolutionary generals of that name, which was made from a piece of silk manufactured from silk raised near Charleston in 1755, and from which three dresses were made in England, one of which was presented to the Princess Dowager of Wales, another to Lord Chesterfield, and the third of which is the one above mentioned. This dress is said to be remarkable for the beauty, firmness, and strength of its material.

From various causes, but chiefly because the country was not as yet sufficiently settled to devote itself to silk-culture, to the neglect of other and more pressing industrial occupations, the culture of silk continued to decrease, until about 1830 the interest in silk-culture in the United States began to be revived, and culminated in the excitement of speculation concerning the *Morus multicaulis*, a variety of mulberry-tree, imported from the Philippine Islands, and the culture of which had been extending for a year or two previously.

Early in this year the Chamber of Commerce at Lyons, France, published a report concerning American silk, in which it was stated that a sample, reeled in Philadelphia by Mr. D'Homergue, was assayed by a sworn and licensed assayer, and was declared to be of an extraordinary quality, and admirably adapted to the uses of fabrication; that it was fine, nervous, good, regular, clean, of a fine color, and, in short, united all the qualities that could be desired. Its value was estimated at twenty-six francs (a little over five dollars) a pound. The Committee upon Agriculture also reported to Congress concerning the culture of silk, and accompanied their report with a bill to promote the growth and manufacture of silk in the United States. The bill was brought up in the next session, but failed to pass.

In 1837, Mr. Adams reported from the Congressional Committee

on Manufactures, to whom a resolution from the House, passed during the previous session, had been referred, inquiring concerning the expediency of promoting the culture and manufacture of silk. In this report the whole subject was discussed, and it was stated that it had been found perfectly practicable to raise mulberry-trees and silkworms throughout the whole of the United States. One acre of the *Morus multicaulis* would sustain sufficient silkworms to raise one hundred and twenty pounds of silk, worth six hundred and forty dollars. The process of reeling had been found easy. The manufacture was as simple as that of cotton or wool, and the necessary machinery was much less expensive. The manufacture of silk fabrics on power-looms had been successfully established, and it was certain that this country could compete successfully with others in this industry. The New England States were all of them engaged in the culture and manufacture, and four of them were encouraging the business by bounties. Silk-companies existed in all the Eastern and Middle States, and in the Southern States much interest was felt in the subject. The Western States were peculiarly adapted to the business, and a number of companies with large capitals were incorporated in Ohio, under skilful managers. The business had been commenced in Kentucky, in Indiana, Illinois, Missouri, and Tennessee.

In 1838 the speculation in mulberry-trees culminated, and single trees were sold as high as ten dollars each. The revulsion followed, and most of the nurseries were abandoned or destroyed. In this year, however, a convention of silk-growers was held at Baltimore, at which two hundred delegates attended. A National Silk Society was formed, and a journal devoted to the silk interest established. In 1839 *Morus multicaulis* trees were offered at three cents each, "healthy and well branched," and it was predicted that the next year they would be sold at three dollars a cart-load. From the disastrous results of this spirit of speculation, the culture of silk suffered severely for some years. Gradually, however, both the culture and the manufacture of silk have attracted more attention, and it is perhaps not among the impossible results in store for us in the future, that this country may eventually come to be among the chief silk-producing countries of the world.

It is within even the short period of our national existence, that indigo, which had become a leading crop of the South, has given place to cotton, the supremacy of which, with the increasing diversity of industry and specialization of labor introduced by the abolition of slavery, seems seriously threatened in its turn, and which will

certainly not remain the only, though it may remain the chief, industry of that section of the country.

The notice elsewhere in this volume of the present successful condition of the manufacture of silk machine-twist shows the results attained by American industry in this branch of silk-manufacture. In the production of silk dress-goods a similar advance has been made, and the quality and texture of the silk fabrics made by Cheeney Brothers at Manchester, Connecticut, have justly obtained a reputation which is gratifying.

The democratic industrial movement of the present era of civilization tends towards increasing the circle of the consumers of luxuries, and, depending upon the people, instead of only upon the small class of the rulers, for the purchasers of its products, seeks to make universal the moral influences of the gratification of our desires, instead of depending upon their suppression or denial for this end.

In the attainment of this needed reform, the silk-manufacture has played an important part, and the almost universal distribution of its products shows how much more general the industrial activity of the present has made the ability for the enjoyment of luxuries than even less than a century ago was possible. To our grandmothers the possession of a silk dress marked an era in their lives; while now to persons whose lives of daily toil formerly forbade the expectation of ever enjoying such a luxury, a silk dress is by no means such an impossible possession.

To keep pace with this increased demand, the cultivation of silk has greatly increased; and though it suffered a few years from a malady which attacked the worms in many countries of Europe, yet the scientific use of the microscope has robbed this disease of its terrors, by showing its causes, and suggesting the sure means for avoiding it. There is no more striking evidence in modern times of the intimate connection and interdependence of the scientific and commercial interests of mankind, than the good service which a purely scientific investigation of the causes of the disease, guided by a scientific method, derived only from the philosophic theories of the students of biology, has done to the cultivators of silk, by giving them a simple and practical means of effectually combating the ravages of this singular parasitic disease, which seemed at first destined to utterly destroy their industry.

Not only has the increased demand for silk led to the extended introduction of this industry, but it has also called attention to other sources of the supply than the silkworm. Various other insects

have been found which also yield a textile material; and varieties of silkworms which feed upon varieties of the oak and other trees have been suggested as valuable for supplementing the supply. Even spiders have been cultivated for their ability to spin silk; and a few years ago a writer in the *Galaxy* devoted several papers to an enthusiastic description of his labors with individuals of a peculiarly hideous species of spider which flourished on the low lands of the Southern Sea Islands. The description of the ingenious kind of harness which he invented for the purpose of reeling out the web from the living spider, together with his accounts of their habits, and calculations of the probably profitable character of this new industry, were quite interesting. Up to the present time, though, these new sources for the silk supply of the world have not come to be commercially of value; yet there is but little doubt that the culture of silk has a great future before it, and that in this country the practical knowledge gained by experience will offer an opportunity for taking advantage of the admirable combination of favorable conditions which this country offers both for the culture and the manufacture of silk.

HATS AND THEIR MANUFACTURE.

THE NATURAL NECESSITY FOR A HEAD-COVERING. — NATURE'S SUGGESTION. — THE VARIETY OF HEAD-COVERINGS USED. — THE MODERN HAT. — THE COLONIAL MANUFACTURE OF HATS. — PROTECTION THEN. — ENGLISH LEGISLATION. — THE TRADE AFTER THE REVOLUTION. — THE PROCESS OF FELTING BY HAND. — SILK HATS. — STRAW HATS. — BONNETS. — WOMEN INVENTORS AND PATENTEES. — THE INTRODUCTION OF MACHINERY INTO HAT-MAKING. — THE RESULTS. — THE EFFECTS OF THE TARIFF. — AN INSTANCE OF ITS INJUDICIOUS PROVISIONS FURNISHED BY HATS.

The wearing of some covering for the head, in order to protect it from the heat of the sun, or to guard the eyes from its too great brilliancy, was probably one of the very first steps made by mankind in their progress from the nakedness of savagism to the wearing of clothes. Besides, too, the head, as it is the seat of the chief organs of the senses by which our perceptions and knowledge of the outside world are received, is naturally the most important part of our organization, and instinctively we protect and adorn it. Nature herself, in covering it with hair, has suggested the treatment which the savage but follows out when he feels himself fully clothed with a head-dress of brilliant feathers.

The shape, the color, the decoration of the various head-dresses worn by different races of men at different periods have been as diverse as the materials from which they have been made. The skins of beasts and birds, mats of leaves, twigs, or straw, cloth, metal, fabrics of wool, have each in turn been impressed into this service. The shape and the decoration of the hat has also been always an important matter. During the Middle Ages, when the social distinctions of the people were more sharply drawn and defined, the hat, by its form, its material, and its decoration, was the chief indication of the social position of its wearer. Jewels and plumes marked the rank of the noble; a sober hue, a simpler form, and a plainer method of adornment, showed that their wearers belonged to a lower social grade; while the worker, the peasant, those who carried on the industrial labors which supported the extravagance of the upper classes, had to content themselves with the simplest of all.

Though in our modern times we are so prone to congratulate ourselves on having freed ourselves from many of the superstitious customs and ideas of our ancestors, yet unconsciously the hat assumes an almost undue importance in our costumes. With our city youths, mounting their first hat marks the attainment of virility almost as certainly as in Rome the assumption of the *toga virilis* marked the attainment of manhood. Nor is there any single article of costume concerning which the modern fop is more curiously careful than he is of his hat. Should he lose it, some gusty day, by a sudden blast, he stands almost as bewildered and ashamed as though he was involuntarily making some indecent display of himself in the public street.

Leigh Hunt, in one of his sketches of London life, gives an amusing picture of the almost reverential respect which the modern dandy has for his hat. He represents himself as looking at the wild animals in their cages in one of the public gardens. Standing before the cage of tigers, and observing these ferocious beasts, together with the crowds of men, women, and children who were standing before them, it suddenly occurs to him how shocking it would be should one of the tigers snap the bars which confined him, and spring infuriated into the midst of the group of women and children. Musingly he concludes that it would be really a sad accident, when, looking at the clouds, he observes a thunder-storm approaching. He sees that it threatens to rain, and instantly the immediate danger of damage to his hat flashes into his mind. "It would be awful," he ejaculates, "should that get wet!" and rapidly flees to a place of shelter. The thought of a tiger loose among a crowd of women and children does not excite him nearly so much as the thought of a shower which should injure his hat.

Among the industries of America the manufacture of hats has always held a prominent position. As early as 1662 the colonial government of Virginia offered a premium of ten pounds of tobacco, the currency of that time, for every good hat made in the Province, of wool or fur. Nor even in those early times was the personal advantage of a monopoly in any important branch of manufacture overlooked. In 1672, John Clough, John Tapping, and other hatters in Massachusetts, attempted to obtain from the General Court the exclusive privilege of manufacturing the hats used in that Colony. The answer of the General Court was one which might be given with profit by the Legislatures of later times to some of the more recent demands for similar exclusive rights. They promised these enterprising gentlemen that they should have this privilege granted them,

"when they should make as good hats, and sell them as cheap, as those from other parts."

Protection, too, was early applied to the raw material of this manufacture. In 1675 the exportation from the Province of wool and raccoon furs was prohibited; and in 1704 the hat-makers of Pennsylvania were given leave to introduce a bill for the prohibition of the export of beaver, raccoon, or any other furs fit for being worked up into felt. Under these circumstances the trade increased so rapidly that, in 1731, the felt-makers of London complained to Parliament that the foreign markets were almost entirely supplied with hats from America, and that hats were even sent into England from America, to the great detriment of their own trade; and that therefore they petitioned to have the export of hats from America into foreign markets prohibited. In consequence of this petition a special committee was appointed to examine the subject, who reported that in New England and New York ten thousand hats were yearly manufactured; that the product of Boston was forty hats a week, which were exported to Spain, Portugal, Ireland, and the West Indies. Parliament therefore enacted, in 1732, that "no hats or felts, dyed or undyed, finished or unfinished, shall be put on board any vessel in any place within any of the British plantations, nor be laden upon any horse or other carriage, to the intent to be exported from thence to any other plantation or to any other place whatever, upon forfeiture thereof, and the offender shall likewise pay £500 for every such offence," with a like penalty for every officer, and £40 for every other person, knowingly aiding in it. This enactment remained in force until abrogated by the Revolution.

It seems singular that so recently such short-sighted policy should have guided the action of a government claiming to be even ordinarily enlightened; and equally strange that when the laws of trade were thus foolishly tampered with, and such absurd obstructions placed in the way of the legitimate growth of industry, that the enterprise, the energy, and the wealth of any nation should have grown as those of England and the United States have done. And yet to-day among the majority of the governments of the civilized world, and our own is not excluded in this enumeration, much of the legislative interference with industry and trade is based upon considerations as foolishly suicidal and as ignorantly contrary to the best interests of those whose rights the legislators pretend to regulate and protect as this was. Fortunately the inherent force of national industry is too strong to be repressed by even legislative interfer-

ence; and if not in one way, then in another, such restrictions are done away with, even though it may be at the cost of conventional obedience to the law.

While this enactment was in force, though its effect was intended to be the destruction of the manufacture of hats in the Colonies, large quantities of them were still made and still exported. After the successful termination of the Revolution, the business increased steadily, and before 1800 was carried on, to a greater or less degree, in almost every State of the Union. By the census of 1810, returns were made from eighteen States and Territories of the manufacture of hats to the value of $4,323,744, while fourteen manufactories in Louisiana were not included in the report. In 1831 a convention of hat-manufacturers estimated the total hat production in the United States, for home consumption and for export, at $15,000,000 yearly. In the census of 1840, however, the value of the hats made in the United States was placed at $8,704,342. This estimate is evidently too low. In 1842 a convention of hat-manufacturers, held in New York, appointed a committee to examine and report upon the introduction of machines for expediting the operations of manufacture in the business. This committee reported that hats were then sold at an average of twenty-five to fifty per cent. cheaper than they were ten years before. Up to this time the manufacture of hats had been carried on chiefly by purely manual labor. This process was tedious and slow.

The fur of hares, rabbits, with wool, and the fur of beavers, is the material chiefly used for the production of felt hats of all kinds. The hair being removed from the skins, the first operation was to clean and then felt it. Felting is a process by which the fibres of wool or other materials are so interlaced, without weaving, as to make a texture. This result is attained by a process called *bowing*. The proper quantity of the material being mixed in the right proportions, according to the variety of felt it is intended to produce, it is violently agitated, tossed in the air, and caused to mix thoroughly, the fibres falling with the greatest possible irregularity upon a table, and thus becoming spread out evenly in a thin sheet, the fibres of which are interlaced in every conceivable direction. This thin layer is then covered with a cloth, and the combination of the fibres increased by pressure. Upon this layer another is laid, by the same process, and so on until the fabric of felt has been brought to the required thickness. The operation was one which required skill, judgment, and experience in the operator, and a competent *bower* was always in demand.

By the old process of manual labor, a man could make in a day about four or five hat bodies, as they are called, that is, the hat in its first state of preparation; so that the cost of each of them was from fifty to sixty cents. As early as 1799 inventions, intended to cheapen the cost of the manufacture of hats, began to be patented in the United States, and many improvements were thus made in the various processes.

The silk hat, or beaver hat, as it is still called from the time when the fur of the beaver was chiefly used in its manufacture, is made from silk plush. The best quality of this is still imported from Paris. This branch of the manufacture is even now conducted chiefly by hand processes. The silk is fitted upon a frame, and the entire structure is moulded into shape by hot irons. The delicacy and accuracy of its lines and curves is a matter of great importance, and requires great skill in the workman. The silk hats of American manufacture are generally acknowledged to be the best made, since they combine strength and solidity with lightness. This last quality is one of prime importance, since the hat is so stiff, and the head is sensitive to weight. The best hats made often weigh less than five ounces each, though it is difficult to combine with such lightness the strength which will enable them to last very long.

Beside felt or silk, straw is largely used in the manufacture of hats. These are specially worn during summer, and constantly in tropical climates. Straw hats were made and used largely in Southern Europe three centuries ago, and the Leghorn hats are still valued and sold at high prices. The material for these hats is a species of wheat straw, which is raised for this purpose upon the banks of the Arno. This branch of manufacture was introduced into England during the last century, and the wheat grown upon the chalky soil near Dunstable was found to furnish a straw so suitable for the purpose, that the manufacture has grown until, by recent statistics, it was stated that seventy thousand persons were employed in it, and the production amounted to near four millions of dollars a year.

In South America certain grasses are found which are most admirably adapted for making hats. Not only are hats made of it, but from this straw, by tight plaiting, the natives make vessels which will contain milk and other liquids. Under the general name of Panama hats, the straw hats imported from South America are well known and deservedly valued. In the United States the manufacture of hats from straw, for both men and women, has long been

established, and in many localities is largely carried on. Not only have the straws from grain been used for this purpose, but many of the wild grasses have been impressed into the service.

In Massachusetts, ladies' hats of fine quality have been made from the field and meadow grasses, known botanically as *Poa* and *Agrostis*, of which the red-top, *A. vulgaris*, has been found to be specially well adapted to this use. In 1798, Miss Betsy Metcalf, who afterwards by marriage became Mrs. Baker, though only twelve years old at this date, and without any previous knowledge of the art, made in Dedham, Mass., from oat straw, which she smoothed with her scissors, and split with her thumb-nail, a bonnet of seven braids, with bobbin insertion like openwork, and lined with pink, in imitation of a then very fashionable style of English bonnets. The straw was bleached by holding it in the vapor of burning sulphur. Her bonnet was very much admired by the ladies of the vicinity, who came from the neighboring towns to see it. Operatives were instructed in the method of their construction by the young inventor, and thus the foundation was laid of an extensive business which was followed in Dedham, Wrentham, Providence, and other New England towns, and elsewhere.

In the Transactions of the Rhode Island Society for the Encouragement of Domestic Manufactures, for 1858, is an account of Mrs. Baker's labors in this direction, and in the society's collections is a fac-simile, from her own hands, of the first bonnet she made.

Nor was this the only instance of the kind. In 1821, Miss Sophia Woodhouse, who by marriage became subsequently Mrs. Wells, and who resided at Wethersfield, Conn., sent to the Society of Arts, in London, England, samples, in their raw, bleached, and manufactured states, of a new material for making straw hats in imitation of those of Leghorn. The material used was the grass known as the *ticklemoth*, a species of spear, or smooth-stalked meadow grass, growing abundantly in that section of country, and named botanically as *Poa pretensis.* The dealers in London pronounced the bonnet sent for inspection superior in fineness and color to the best Leghorn, and advised the cultivation or importation of the straw as a means for obtaining a desirable supply of material for the manufacture.

At the next session of the society a large silver medal and twenty guineas were voted to Miss Woodhouse, on condition of her furnishing the society with some of the seed, the description of the bleaching process, and the treatment of the grass, and also evidence

that she was the original discoverer of the process. This same year a patent was granted to Garden Wells and Sophia Wells of Wethersfield, for the above process of making bonnets and hats of grass.

The Misses Burnap, of Merrimac, N. H., also at about this same time claimed the discovery of a proper material in that region for the manufacture of bonnets, and one made by them sold for fifty dollars, in Boston, at auction. Premiums were offered in New York for the best bonnet of domestic material and manufacture, and in many parts of the country the business was established on a permanent footing.

In 1826 the manufacture of palm-leaf hats, from the material imported from the West Indies, was begun in Massachusetts, and in 1831 two millions were made and sold, and this branch of manufacture is still an important one. In 1830 the value of the hats manufactured in the country was estimated at ten millions of dollars, and the exports reached half a million in value.

With the growth of this business various improvements have been made in the processes, and the use of machinery has been introduced to simplify the manufacture and cheapen the cost. In the manufacture of straw hats the results attained have been considerable, and though hand labor is still chiefly relied upon in this branch of the business, yet many of the other processes have been greatly facilitated by machinery. In the manufacture of felt hats, however, ingenious machines have been invented and improved, until the whole process of production is performed by them with a rapidity and accuracy unattainable by other means, and with a proportionate benefit to the consumers.

In 1846 a patent was taken out by H. A. Wells for an improvement in a machine for felting, by which the process was applied to the making of hat bodies, the term applied to the rough form of the hat. By the use of this machine, which has been modified and improved, all the felt hats made in this country during the past few years have been manufactured. A perforated metallic form, shaped like a cone, is made to revolve, and, by a current of air forced through it, gathers and felts the fibres of hair and wool which are kept in a constant state of agitation about it.

By the introduction of this process, the cost was so reduced that not only was the demand at home fully supplied, but about one seventh of the entire production was exported, and a large and profitable trade in American hats was established with the rest of the

world. By the census of 1860, the total value of the hats made in the United States was given as nearly seventeen millions of dollars. At present, however, by the operation of the injudicious provisions of the tariff, the export trade in hats is entirely destroyed, while the home trade finds difficulty in holding its own. The duties laid upon every imported article which enters into the composition of a hat, and they are almost every one, — the fur, the plush, the bands, and other articles, made by other countries, and either are not or from natural causes cannot be made in this country, — causes them to be so dear to the manufacturer, that, notwithstanding the superior advantages which his machinery gives him, he can be undersold by the importer of hats made abroad. Of the whole range of our industries which have been injured or destroyed by the working of the present tariff, there is none which gives a more convincing evidence of the ignorant injudiciousness with which it has been constructed, than this of hats.

ILLUMINATING GAS.

THE RECENT DATE OF OUR KNOWLEDGE OF GASEOUS BODIES. — THE FIRST USE OF GAS FOR ILLUMINATING. — THE INTRODUCTION OF GAS INTO THE UNITED STATES. — THE HYGIENIC EFFECT OF A LEAKY GAS PIPE. — NATURAL SUPPLIES OF GAS. — THE PROCESS OF MANUFACTURE. — THE IMPROVEMENTS MADE IN THE METHODS. — THE STANDARD FOR THE ILLUMINATING POWER OF GAS. — GAS MADE FROM ROSIN. — THE EXTENT OF THE GAS BUSINESS. — THE MONOPOLY OF THE GAS COMPANIES. — THE ADVANTAGES THEY TAKE OVER THE CONSUMERS. — HOW SUCH MATTERS MUST BE REFORMED.

A SCIENTIFIC knowledge of the gaseous or aeriform condition of matter has been in the world only about two hundred years, while the knowledge of its properties, and the experimental skill with which this was gained, form one of the brightest trophies of the modern scientific era. In this, as in other departments of knowledge, we passed through the purely scientific period of theory before arriving at the period of practical application to our comfort.

In 1792 Mr. Murdock, who then resided at Redruth, Cornwall, England, commenced experimenting upon the practical application of coal gas for illumination, and in 1798, having become associated with Bolton & Watts's workshop at Soho, in 1802, at the illumination for the peace of that year, this building was illuminated with gas, made by an apparatus of his construction, and this was the first public application to practical use of gas for illumination. It grew rapidly in public favor, until, in 1813, the streets of London were lighted with the new agent.

The original idea of gas had been derived from experiments in coking coal, when it was noticed that the vapor passing off would burn ; but experimenting chemists soon discovered that other materials, as oil, waste grease, etc., would also produce the new illuminating agent, and with much greater brilliancy. In the first lighting of the cities of London and Paris, these materials were used, but soon after abandoned, and coal substituted, because of its greater cheapness.

The first attempts to introduce gas into the United States were made in Baltimore, from 1816 to 1821, and were not then successful. In 1822 it was introduced into Boston, and in the following year the first gas company was formed in New York city. This was called the New York Gas Company, and commenced operations with a capital of one million dollars. So limited, however, were the demands, or so slow were the people to take the new material, that this company was not in active, successful working order until 1827. Three years afterwards its success was assured, and the Manhattan Gas Company was originated. Both these companies, however, used rosin and oil for the manufacture of their gas until the year 1849.

From this beginning have arisen the immense establishments which now furnish light to our cities, and the hundreds of smaller ones which light up our villages and factories throughout the land, there being hardly a town of any pretensions which has not its gas works, and uses this mode of illumination.

Chemically considered, our illuminating gas, derived from coal, is composed chiefly of carburetted hydrogen, carbonic oxide, and olefiant gas. The last is the principal agent in producing light. Carburetted hydrogen is the fire-damp of our coal mines, while carbonic oxide is the bad air, or choke-damp, produced by the explosion of the light carburetted hydrogen. The carbonic oxide is heavy, and seeks the lowest strata, while the other floats to the top, and, on opening a door, immediately seeks access at the shaft. Thus we introduce for our comfort into our households two natural substances, which have produced the most terrible disasters in the history of our mining industry. Yet they are so combined, as we use them, that they are comparatively harmless. The very oxygen, which is an absolute necessity to our existence, would soon kill us if we breathed it alone; so would an atmosphere composed of illuminating gas. Yet a small portion of it might be disseminated through our air without any other injurious effect than to produce a disagreeable smell. At the same time its excess renders the air inflammable, and while of itself it is not explosive, the point remains yet undecided whether, in close apartments where there is only a limited supply of atmospheric air, it may not be saturated to the explosive point with the gas we burn. But in the open air there could not possibly be anything more than a great puff and an immense burst of flame.

Any one, however, can understand that it is neither pleasant nor

safe to have a leaky gas-pipe. With many persons of delicate, nervous systems the smell produces headache and dizziness. This is frequently caused by the preponderance in the gas of an undue proportion of carbonic oxide. In fact, it is the endeavor of gas manufacturers to extract all this noxious ingredient; but that object is very seldom fully attained.

As it is an utter impossibility for us to have flame of any kind without oxygen, hence burning gas in our close rooms in winter necessarily decreases the amount of oxygen in our atmospheric air, and thereby renders the air we breathe less invigorating and less capable of performing its function of oxygenating the blood in the lungs. To our habits in this respect, and our thoughtlessness of the injurious result, is due, in great measure, the prevalence of consumption. Europeans burn gas in their streets and public places, but by no means as commonly in their homes as we do.

As has been stated, all kinds of illuminating gases are derived from hydro-carbons, or combinations of hydrogen and carbon.

Within a few years past a new species of gas has been introduced, new and yet old, for from all time the earth has yielded the natural gas of Asia, of Trinidad, of Western New York, and Virginia; but only within a few years past has the same substance been derived from petroleum. This gas is strictly a hydro-carbon, and is frequently found almost in perfect purity, having none of the nauseous odor of our city gas from coal, and in general not its poisonous tendencies.

The process of manufacturing gas is not merely a mechanical operation, but also requires the aid of chemical science. In fact, chemical science directs the mechanical work. First, the coal is selected and properly mixed. Experience has shown that no one variety of coal serves all the requirements of the gas manufacturer. He desires a coking coal, that he may burn the coke under his retorts. Cannel coal yields much gas, but makes a poor coke; rich, bituminous coal gives a good coke and a fair quantity of gas, but it is liable to cling to the sides of the retort, and its coke, when put in the furnace, is apt to "eat" the brickwork, and cause rapid wear. Hence he mixes these two; but on testing his gas, he finds that it has not sufficient "candle power;" hence he must have more olefiant gas to enrich it. To obtain this, he adds some Trinidad asphalt, or Breckenridge, or Ritchie mineral, or Albertite. Hence, to make good gas, experiment has shown that four or five different coals are best — a poor bituminous, a rich bituminous, a

little cannel, and an asphalt mineral. Some add more, geologically of the same class of coals, but coming from different localities, and acting differently in the retort and the furnace. Thus the block coal of Indiana does not coke of itself; but mixed with a strong coking coal, it unites with that, forming a coke of dryer nature, more like an anthracite, though, of course, not so hard.

Rosin was formerly used to enrich gas; but at present the prices, even of the commonest grades, are too high to admit its profitable use. In many of the smaller towns it is yet used alone as a material for producing gas. Some establishments enrich their gas by passing it through petroleum, or by mixing with it air which has been passed through petroleum. This is a patented process.

The materials for making gas, then, are, bituminous coals and asphalts, rosins, rosin oil, and petroleum. It will be best to commence with the process by which the first is treated. The coals, being selected and mixed, are placed in retorts. These retorts are now usually made of fire-clay, but were formerly iron. They are made with one end entirely closed, while to the other are fitted an iron frame and door. They are set in brickwork, usually five over one fire, and these are called a "bench." From the iron framework at the door goes up a pipe, connecting with pipes from the other retorts, and then to the main pipe, by which the gas is carried to the condensing-receiver. The retorts are about nine feet long, and shaped like a letter D turned on its flat side. The fire is applied, and the gas soon begins to pass over.

In the condensers it is cooled, and a great part of the tar and ammoniacal water settle; but it must be further condensed, and for this purpose is passed through a series of vessels, called "scrubbers." Here it is made to pass up through a mass of stones, or coke, meeting a stream of water coming down. This is termed "washing," and was at first done with common water; but as it was found that the water absorbed certain portions of the gas, thus making it poorer in illuminating power, and necessitating more expense for enriching material, Mr. Havens, of the Brooklyn City Gas Works, introduced the system of washing with ammoniacal water, and also substituted twigs and billets of wood for the stones or coke.

From the scrubbers the gas passes to the lime-purifiers, where it is deprived of the remainder of its ammonia, of any superabundance of carbonic oxide, and of the sulphuretted hydrogen.

While the lime purifies the gas, the use of this material is objectionable on account of its giving off the sulphuretted hydrogen when it is taken out of the purifiers and exposed to the air. Hence many substitutes have been tried, and while it has been found impossible to dispense with the lime entirely, as it alone will extract the carbonic oxide, yet a great improvement on the old system is the use of hydrated peroxide of iron. This substance extracts the sulphuretted hydrogen perfectly, and afterwards the sulphur is taken from the iron, and that article revivified and used again. It is as yet a patented process in this country, and entirely obviates the intensely nauseous smell usual from gas works.

During the process of passing through the purifiers, every few minutes the gas is tested by letting a small stream touch a paper which has been dipped in a solution of sugar of lead. If this paper becomes in the slightest degree discolored, the gas is immediately stopped from passing out to the gas-holder, and made to run into and through another purifier spread with fresh lime.

The lime used is generally derived from oyster-shells, and costs but little. After use and exposure to the air to evaporate the sulphuretted hydrogen, it becomes a valuable manure, especially for grass lands. It is somewhat singular that in such a vast industry there have been so few material improvements, and the process of manufacturing and purifying gas has remained substantially the same for many years.

To effect the passage of the gas through the lime, that substance is spread on a series of wire trays in a tight iron box. The gas is usually passing through three of these at once, and the fourth is kept ready in reserve to run the gas into it as soon as the test shows that it is coming from the others with the slightest impurity.

In most works the trays have to be emptied one by one with shovels and barrows, which is a tedious, disagreeable, and unhealthy job; but Mr. S. C. Havens has patented an arrangement of purifiers on railways, by which, when ready to clean out, they will be run on a track to the dumping-ground. This is vastly to the benefit of the health of the workmen, and also a saving of time and labor. This and a few slight mechanical operations are all the improvements which have been made in the manufacture of gas.

From the purifiers the gas goes to the receiving and distributing tank. At this point in the manufacture it is asserted that a

certain quantity of atmospheric air is mixed with the gas. Good gas will absorb a certain amount of air without great detriment, yet such mixture is a cheat and an adulteration; and while there is but little doubt that all of the companies do thus mix air with their gas, yet but few, if any, of them will acknowledge the fact.

The receivers or gas-holders are large tanks, made of wrought iron, and swing from tall cast-iron columns. They are thus swung and balanced, so that, when empty of gas, they sink into pits lined with cement, and prepared for their reception. As they fill with gas, which is let into them from the bottom of the pit, they rise up, guided by the pillars, and accurately balanced by weights. Some of these tanks are of enormous size. The largest in the United States is at the Manhattan Gas Works, the next is at the Brooklyn City Works, and the third in Philadelphia.

From the holders the gas is distributed, by main and branch pipes, through streets and into dwellings. In the city of New York there are four hundred and ninety-three miles of street mains and eighteen thousand and seventeen street lamps. Some idea of the enormous amount of gas consumed may be inferred from the fact that these street lamps alone consume one hundred and thirty-four million three hundred and sixty thousand four hundred and eighty-three cubic feet per annum. In European countries, while gas is not used so generally in the houses, their streets are ten times as well lighted as ours; and while they have not that greater proportion of lamps, yet their gas is far better.

Gas is measured for its illuminating strength by a standard, called "candle power;" that is, twelve-candle power is assumed to be twelve times the light given by the adamantine candle, or the same as twelve such candles. The United States standard is generally sixteen-candle power; but, with the gas usually furnished, a large burner must be used to get that much light.

The best gas coal known, and that generally considered a standard, is the best English Newcastle. It yields about eight thousand cubic feet of gas, and a very superior coke. Cannel coal usually yields about eleven thousand feet, but no coke of value. Our gas companies use the Albertite, from Nova Scotia; Ritchie mineral, from Virginia; Westmoreland bituminous, from Virginia; various bituminous coals, from Pennsylvania; the Breckenridge cannel, from Kentucky; a Nova Scotia bituminous; the Trinidad and Cuba asphaltums; and the Forbare or Boghead cannel, from Scotland. These cost from seven dollars fifty cents to twenty dol-

lars per ton, and large stocks of them have to be kept constantly on hand. Some coals contain large quantities of sulphur. These, when packed in great masses, will generate heat and take fire spontaneously. This is prevented by having pipes passing down through the mass, and also by constant care. These pipes are often found so hot as to be decidedly unpleasant to the hand.

For small towns the expense of the works necessary for the manufacture of gas from coal renders the production of this gas impossible; and hence, in such cases, rosin and rosin oil are generally substituted as a gas-making material. The gas made from these substances has, further, the property of remaining unchanged for many days — an advantage not possessed by coal gas. It is also much more brilliant, being more strictly an olefiant gas. The process of manufacture is similar to that of coal gas. The rosin is melted, and run in a small stream into a red-hot retort filled with anthracite coal. It there vaporizes, and passes through condensers into the receiver. No purification is necessary.

For factories, hotels, private houses, and small towns petroleum has of late been much used as a gas material, and many patents have been granted for machinery and processes whereby this fluid can be used. The prevailing principle of all of them is pumping air through the petroleum by one or another means. The air absorbs a large quantity of the olefiant gas, and gives a brilliant flame. Some of these patented machines are utterly worthless; others are very valuable for the use intended.

The capital invested in the manufacture of gas in the United States is estimated at over sixty-five million dollars, and there are a few over seven hundred companies. The coal gas ranges in price from two dollars to three dollars fifty cents per thousand feet, and that from rosin seven to eight dollars. The amount consumed reaches to thousands of millions of cubic feet; and in the direct manufacture, the supplying of fire-brick and retorts, the manufacture of gas-fixtures, — pipes, burners, shades, etc., — an immense army of laborers, and some of the best talent of the country, are constantly employed.

Chemically considered, there are none of the illuminating substances so cheap and at the same time so powerful as gas. The objection to the use of it is the unprincipled system by which many companies take record of the consumption of their customers. Hitherto it has been held that legislation should not busy itself in interests of this character, but leave all to the levelling

principle of competition. The history, however, of the introduction of gas for public use by joint-stock companies has given another instance of how rapidly they combine to maintain their monopoly against the public. As a rule, the gas furnished by the companies of our cities is very much below the standard in illuminating power, and much higher in price than it should be. Besides this, the gas companies, by their system of demanding deposits from their consumers, — in fact, without a particle of right or justice, — collect enormous sums of money, which they have the use of without interest. By this system, combined with their excessive charges for poor material, and the unreliable system of metres which they generally use, and which over-measure the supply consumed, the business of gas-making has become a most profitable *ring* in every city where it is in use, and the stock of the various companies is very seldom found offered for sale.

With the new commercial era of the present time, the reform of this, with other monopolies, is to be brought about as the political evils of the same character, caused by the monopoly of government by a class, were redressed by the political movements of the last century. The necessity for a better social organization, by which the material interests of society shall be intrusted to the people themselves, to be carried on by their delegated authority in their own interest, as the political expression of their will is secured in this country by the reform in the suffrage, is daily becoming more apparent and more pressing, and among such material interests there is not one of more importance than the good and cheap supply of gas, for it means the supply of good and cheap light, and light is an important factor in the activity and life of society.

NARROW TEXTILE FABRICS.

EXTENT AND SIGNIFICANCE OF THE TERM. — PORTRAIT OF MR. WILLIAM H. HORSTMANN.— HIS LIFE AND BUSINESS CAREER. —INTRODUCES THE JACQUARD LOOM INTO THE UNITED STATES. — CONTRAST OF HIS EARLY WORK AND THE PRESENT CONCERN. — THE DEPARTMENTS OF W. H. HORSTMANN AND SONS' ESTABLISHMENT. — MATERIAL ROOM. — SPOOLING ROOM. — ENGINE, MACHINE SHOP, AND CARPENTER SHOP. — SWORD DEPARTMENT. — TASSEL ROOM. — POWER LOOM, COACH LACE, AND OTHER WEAVING ROOMS. — SILK ROOM. — SALES DEPARTMENTS. — LADIES' DRESS TRIMMINGS. — NOTIONS AND SMALL WARES. — HOSIERY AND GLOVES. — ZEPHYR WOOLS AND EMBROIDERY. — UPHOLSTERY AND CARRIAGE TRIMMINGS. — FLAG ROOM. — MILITARY, REGALIA, AND THEATRICAL GOODS. — GENERAL IMPRESSIONS FROM VIEWING THE ESTABLISHMENT.

THE title of this chapter is far more comprehensive than might at first be imagined. It includes goods woven from all the various textile fibres, — cotton, wool, silk, etc., — in an infinite variety of styles, colors, and patterns, and used for an astonishing variety of purposes. These extend, indeed, literally from the cradle to the grave ; for the single firm of William H. Horstmann & Sons, of Philadelphia, from whom much of the information here given has been obtained, furnish narrow woven goods, alike for decorating the toilet and the cradle of the infant, the dresses of ladies and gentlemen, young and old, the upholstering of houses and of carriages, the uniforms and equipments of officers and soldiers, the regalia of all manner of societies, the costumes of the stage, and, last of all, for the melancholy ornaments of the coffin and the funeral.

The history of the origin and progress of this one firm, indeed, of itself shows very strikingly how immense is the demand for their staple articles, besides affording an interesting example of business energy, judgment, and success, and an excellent instance

of a business establishment at once of immense extent, extraordinary variety in production, skilful organization, and sound and safe management.

In the counting-room of their great manufacturing and wholesale establishment, at the corner of Fifth and Cherry Streets, in Philadelphia, hang two interesting memorials, carefully framed and glazed. The oldest of these is a small hand-bill, printed in English and German, dated at Philadelphia in 1793, signed by Mr. Hoeckly, and setting forth that he makes fringe, coach lace, and tassels. The other, which dates to a period about a quarter of a century later, is a well-executed life-size crayon portrait of a young man, with an open, sensible face, a kindly and genial expression, and wearing the high-collared coat of those days. This is a picture of William H. Horstmann, the founder of the present firm of W. H. Horstmann & Sons, and whose name, though he is now deceased, is retained in the firm name from a feeling of filial pride, which is very graceful.

Mr. Horstmann was a native of Cassel, in Germany, and learned the trade of silk-weaving in France. He came to this country in 1815, and established himself in Philadelphia, where he began to manufacture trimmings of various kinds. He married the daughter of Mr. Hoeckly, and she became a faithful and efficient assistant to her husband in his business. Mr. Horstmann's natural talent for invention very soon began to find a field, his first improvement being additional varieties in styles of coach lace, there being only two patterns at that time used in the trade, called the Jefferson pattern and the Monroe pattern. In 1824 he introduced into the United States, from Germany, the use of plaiting or braiding machines, and about the same time he was the first to introduce into this country the use of the Jacquard loom, for weaving patterns in textile fabrics.

Mr. Horstmann's business, under his constant and judicious attention, steadily increased, and in process of time, instead of working in his own little home, with his wife as his only assistant, he was obliged to occupy larger premises, and to employ subordinates. The house where he first established himself in business stood within a few rods of the immense building now occupied by his sons. He did not, however, live to see the erection of this extensive and complete combination of manufactory, ware-room, and sales-room.

During the half century and more which has passed since the

landing of the solitary young German upon our shores, the business which he established, from being simply one workman's supply of one single article of goods, has expanded and developed into a great industrial establishment, employing hundreds and hundreds of hands, wielding a vast capital, and having the highest business reputation and extensive business connections on both sides of the Atlantic. Instead of "coach lace," an article named in two monosyllables, and furnished in two styles, the firm now manufactures or supplies so many articles that the list of the names of goods in a single department fills, in more than one instance, a neat little pamphlet, and in place of one little room stands a massive and imposing structure, six stories high, and stretching for a hundred feet along Cherry Street, and a hundred and forty on Fifth Street. The separate departments into which the manufactory and sales-rooms are organized are thirty or more in number. In place of one single hand-loom, more than a thousand separate looms and machines of all kinds, many of them very costly, a number of them invented, and used expressly and exclusively for the firm, and mainly driven by a powerful steam engine, crowd floor after floor; and the list of materials used in the business includes the chief metallic and textile raw materials of the world, besides numerous subsidiary ones.

A brief enumeration of these departments, and their appearance and contents, will give the best attainable idea of the extent and character of the business of the firm.

We may begin with the "material room"—a basement room, an airy, well-lighted, and excellently ventilated place, as indeed is every part of the premises; it is not a very large room, but frequently, we are told, contains a hundred or two hundred thousand dollars' worth of the costly raw materials used by the firm. One side is filled with a range of shelves, holding an endless assortment of silk, of various tints, spooled and ready for use. In other places are great packs of the delicate grayish-white raw silk, in large twisted hanks, as it is imported; and other masses of other material crowd the rest of the room.

The "spooling room" is next—a long, wide, and roomy place, at one side of which stands a row of frames, placed parallel to each other, like the benches in a country lecture-room. Each of these carries a number of the "spools," and all together they give room to wind about three hundred and fifty spools at once. The other half of the length of the room is occupied by what looks

MANUFACTORY OF WM. H. HORSTMANN & SONS, PHILADELPHIA.

like a miniature ropewalk, — and so it is, we are told, — a "cord-walk," where silk cord is made.

We glance at the steam engine, — of fifty horse-power, — and chat a moment with the engineer, a powerfully-built and sensible man, to whom we speak of the last steamboat explosion, and of a theory published a day or two after it that it was caused by oil in the boiler. The engineer laughs, and in half a dozen words shows how the ordinary working of the engine must constantly be carrying more or less oil directly into the boiler all the time ; and, he says, it is a very common practice to put oil in on purpose, to help clean out the inside of the boiler. He remembers, when he was younger, that he has seen his chief pick up a dead hog in the street, and fling the body whole into the boiler, that the fat might operate in this way.

Then we go into the machine shop, where a thoughtful, slender man is setting up a machine newly invented by him for the use of the firm. We chat a little with him, and find him a thorough lover of mechanics and inventions. He says it is better not to take out patents for improved machines, because the model shows some smart, piratical fellow how to evade your patent, or how to surpass your invention ; but if you simply hold your tongue, keep your machine to yourself, run it for your own purposes, and avoid showing it, you may have the good of it, and you are sure to avoid the hateful and almost inevitable warfare of infringement suits.

Next, — for we are not following the course of the manufactured material, but taking the departments as they come conveniently, one after another, — after a glance at the carpenter's and turner's shop, we enter the sword department, which furnishes regulation swords of all kinds, for army or navy, cutlasses, rapiers, foils, the showy weapons used by secret and other societies, etc., etc., completely finished, with hilt, scabbard, belt, and all the trappings. This seems a business rather aside from the peaceful purposes of the loom. But the sword business grew naturally and immediately out of the established army and navy goods department of the firm, the sword-belt and other trappings requiring to be furnished all complete along with the weapon. The blades are not forged on the premises, of course ; but are all, or most of them, of all kinds, imported from the ancient German sword-blade emporium of Solingen, where, it is said, swords have been made ever since the year 1147, when Count Adolphus of Berg brought home from

the East, and established there the business of forging Damascus blades. We examine a magazine of some thousands of blades, of forty or fifty different patterns and sizes, waiting to be set and finished ; the rooms where the hilts are made, and the engraving, gilding, chasing, etc., executed ; we wonder at the infinity of small fixtures used ; we begin to count up the different pieces of a completed sword, and find that there are between thirty and forty in the sword and scabbard alone, without belt or accoutrements of any kind. How costly a sword would the firm furnish? "O," says our guide, with a smile, "we will furnish one as costly as required. A presentation sword could easily enough be made to cost thousands of dollars, by setting the hilt, for instance, with a sufficient quantity of diamonds. But four or five hundred dollars, as things go, would be a price for the finest kind of presentation sword."

We cross from this abode of Mars to the more peaceful precincts of the weaving rooms. We examine the tassel room, where a whole regiment of bright-looking girls, comfortably seated at low tables, with little machines of various kinds before them, are turning out a most variegated lot of tassels, buttons, and ornaments of all sorts. Watch this young person. She picks up a "button-mould," — a flattish wooden disk, about as large as a nickel cent, — puts it on a little prong, leads the end of a silk thread to it, and whirls a little crank. The button-mould turns deliberately round once, the bright, glossy silk flies round and round it as it turns, and in far less time than we have used in the description, the wood is completely covered with the shining thread ; the girl snips the silk off, dips out a tiny particle of mucilage from a little cup, dexterously gums down the end, picks off the button from the prong, puts it in a basket, and puts on another mould. Of all the hundred or more hands at work in the room, hardly any two are at work on the same kind of goods. Sometimes they are all making the same. If we come in to-morrow, a totally different set of articles may be in hand. Here at one end of the room some epaulets and pompons are being made ; and our guide informs us that of the two or three elderly people sitting at this work, one has been twenty years employed by the firm, and another forty years. Perhaps this long endurance of such relations is not less creditable to the powerful firm than its power itself, or its own long duration.

We pass to the power-loom rooms, one for coach lace and one

for other styles of weaving. In these two great rooms nearly two hundred and fifty of these costly machines are set up, of which a goodly proportion are banging away in the exercise of their vocation, and doing good work too, though greatly to the interruption of mere talk. We watch for a long time the growth of the patterns in various fabrics that are coming through the Jacquard looms, whose long festoons of perforated cards, hung up above, are quietly pouring over and over, in an endless chain, each strip of pasteboard, as it lifts one selection of wires and leaves another, according to the requirements of the design below, repeating and perpetuating the singularly ingenious conception of the dead Joseph Jacquard, and of his predecessor, Vaucanson,— thoughts of seventy-five and one hundred years ago, but here set forth over again, millions and millions of times every year, somewhat as the Asiatic idolater believes that every whirl of his "praying machine" is credited to his account, as one repetition of the prayer printed on its circumference.

The coach-lace room is to the same general effect, though the looms are smaller, and the process of weaving less elaborate. The braiding machines detain us long, with the magical dance of their whirling bobbins, a wonderfully intelligent-looking combination. The cord to be covered with braid is drawn deliberately through an opening in the middle of a flat, circular, metallic plate, perhaps fifteen inches across. Up to a point on this cord, about a foot above the plate, the threads of the braided material converge to it, like the ribs of a tent-roof, and there they weave in and out, and out and in, as the coating of glossy braid steadily grows, and the completely covered cord rises and rises, and is wound away above. The weaving is accomplished by the motion of the spools below, that carry the different threads of the braid. These spools stand in uprights, which are carried round and amongst each other in curved slots, in the broad metallic plate aforesaid. All but two of these spools dance in and out among each other, with a swift, easy, intricate motion, like the "ladies' chain" of a cotillon, but so rapid that the eye can hardly follow it; while one or two special spools dart steadily round and round among their twisting brethren, so swiftly that you cannot conceive why they never interfere. It really looks as if each braid were executed by a population of little spirits, with such a close resemblance to perception and life do they jump about. Our guide evidently enjoys our admiration, but carries us off to see, what he says is even a more in-

telligent-looking mechanism than this. It is a coach-lace loom, with a provision for leaving a layer of close-shorn loops on the right side of the fabric, as is done in Brussels carpeting. These loops are shaped upon a bright steel pin or needle, like a short knitting-needle; and the intelligence in question is applied to the handling of these needles. There are not many of them; and as the fabric passes through the loom, a deliberate, quiet little steel finger and thumb takes needle after needle from a place underneath, glides silently up, and calmly lays them across the threads of the warp just in time to have the loops laid over by them. Perhaps a dozen at once are thus lying together, each in its own range of loops, but never more; for just below, another steel finger and thumb, with the same funny, deliberate certainty of motion, glides up at the other side, nips one needle at a time, pulls it backward out of the web, and deposits it underneath on the band that is to carry it back, to be picked up and put in again. The contrast between the quiet gravity of this proceeding and the abandoned jollity of those furiously-dancing braid-bobbins, has something extremely grotesque in it, over and above the interest of the ingenious mechanism itself.

Well, we examine also the silk room, where the silk is washed, wound, and made ready for use in the looms; the warping room, another room full of narrow-fabric looms; another "cord-walk," clear up at the top of the house, — and everywhere we find the extremest order, perfect cleanliness, abundant light and air, rank after rank of every needful variety of machinery, some clacking and rattling in full headway, others just in preparation; for it may take two or three hands a number of hard days' work to get a single loom ready for weaving some of the more complicated sorts of work; others still waiting quietly for some order suited to their particular capacity; and then we cross over from the manufacturing department to the sales departments.

Extensive as are the manufacturing facilities of the firm, and great as is the range of goods actually made by them, they do, in fact, import and sell — at wholesale always — a very great quantity and variety of articles besides. In fact it is here that the goods offered by the house are to be seen. What has thus far been spoken of is not the goods, but the raw material, the machinery, the processes. So we are taken through another entirely distinct, but almost equally extensive, series of separate departments, crowded from one end to the other with a bewildering va-

riety and quantity of things, varying from the cheapest to the most costly, from the most common matter-of-fact and even solemn to the most unusual, bizarre, and ludicrous. There is the ladies' dress-trimming department, showy with all manner of laces, and fringes, and nets, chignons and switches, and other mysterious adornments ; the notions and small wares department, whereof we despair even more to enumerate the contents ; the hosiery and glove department ; the zephyr wools and embroidery department, where six thousand four hundred different shades of color are shown, including Berlin wool and the greatly admired Germantown wool, both for embroidery ; coarser domestic yarns, embroidering silk and chenille, beads of all kinds, and every description of embroidering apparatus, needles, patterns, etc. Here we inquire where the fashions come from. "From Paris and Berlin," is the answer.

Then we see the upholstery and carriage trimming department, with no end of curtains, tassels, cords, laces, gimps, fringes, and trimmings of innumerable kinds. Then comes the flag room, where all sorts of bunting, flags, banners, staffs, and fixtures are on hand, or else promptly executed to order. We suggest that the Fourth of July is likely to make a vacuum in the department, and are told, Yes ; and that, moreover, any great public ceremonial of the processional kind is likely to do so, as, for instance, the procession of the Germans in honor of the Prussian victories over the French, which utterly drained the stock of flags, German and other. Of course when such an occasion is appointed, it is a matter of ordinary business forethought to have a quantity of goods made up in readiness.

Lastly, we examine the military, regalia, and theatrical goods department, altogether the queerest and most entertaining of all. In contemplating this extraordinary array of ornaments and disguises, we cannot help considering the interesting and intimate relation between the bloody trade of the soldier and his exceptional supply of outward decorations. Perhaps there is a still more curious parallel to be drawn between the modest splendors of the real military goods and the incomparably greater effulgence of the weapons, trappings, and ornaments which constitute the regalia of the various societies, or the still more glorious display of the theatrical department. The crowns, jewelry, weapons, gold and silver tissues, plumes, and decorations of every kind here displayed would overwhelm the very soul of the spectator were he

ignorant of the true nature of the pecks of glass, and copper, and tin trash that glitter so tremendously at him. The masks, monkey dresses, devil dresses, and other costumes, tights, beards, and theatrical and costumers' materials of every kind, open a whole new world of trade to one not familiar with the exigencies of the stage.

In addition to the departments already described, the firm is represented by two stores in New York, — at 540 Broadway, for the sale of military goods, regalia, etc., and at 412 Broadway for other articles enumerated above. The agency in Paris is at No. 38 Rue Meslay.

Probably there is no other single concern in the United States whose business and business premises, inspected after the manner of the preceding account, would so powerfully impress the spectator with the immense extent and variety existing within even single branches of commercial industry at the present day, and of the wonderfully great number of apparently different sorts of work and of trade which can be carried on in entire harmony, and with large success, within one and the same concern by attention, foresight, energy, and order.

CARRIAGE-BUILDING.

WHEELS, NUMEROUS AND FEW. — ANCIENT TWO-WHEELED CHARIOTS. — THE GREAT IMPROVEMENTS IN CARRIAGES ARE MODERN. — CARRIAGES USELESS IN THE MIDDLE AGES. — GRADUAL INTRODUCTION OF COACHES IN THE FIFTEENTH CENTURY. — DESCRIPTION OF AN EMPEROR'S AND AN AMBASSADOR'S COACHES. — THE FIRST SPRINGS. — SUPERIORITY OF AMERICAN WHEELED VEHICLES. — START IN BUSINESS OF MR. WILLIAM D. ROGERS. — GROWTH OF HIS BUSINESS. — EXTENT OF PRESENT PREMISES. — DESCRIPTION OF THE DEPARTMENTS OF THE ESTABLISHMENT. — LUMBER DEPARTMENT. — SMITH SHOP. — BODY ROOM. — PAINTING AND VARNISHING ROOM. — DUST, HOW EXCLUDED. — WHEEL ROOM. — TRIMMING. — MR. ROGERS'S OWN CHARACTER IMPRESSED ON THE CONCERN. — HIS PERSONAL APPEARANCE. — HIS CONTINUED SUPERVISION. — CHEAP WORK NOT SOUGHT. — EXTENT OF HOME AND FOREIGN ORDERS.

THE "palace cars" of these days of railroad history have twelve wheels. Mr. Edgeworth, the father of Maria Edgeworth, the novelist, and a man of many fancies, invented a gig with only one wheel, — a horse-wheelbarrow, so to speak, — which was kept upright by girthing the shafts fast at the horse's sides, at the saddle. These, however, as well as three-wheeled vehicles, are exceptional cases, not to mention the proverbial case of the "fifth wheel" of a coach. A carriage, properly so called, has four wheels.

Two-wheeled vehicles — seemingly used at first exclusively for war — were, however, undoubtedly the most ancient, and their first use was at a period before either printed, carved, or painted records. These chariots are named in the *Book of Exodus*, painted on the Egyptian tombs, and carved on the ruins of the Assyrian palaces; so that they were in ordinary use from 1500 to 2500 years before Christ. Thus the wheel, which is the chief invention in everything of the carriage kind, was one of the primeval human devices.

As is the case with many other things, the modern carriage has

been brought to its present perfection within a comparatively very short period, after wheeled vehicles generally had remained between thirty and forty centuries without any very great changes. In the age of chivalry, and afterwards, it was reckoned discreditable for men to ride in covered carriages, which began to be known a little after A. D. 1500. Something of the kind had been used among the Romans, but had apparently gone out of remembrance. This opinion of the shamefulness of using a carriage was remarkably suitable for an age when war and hunting were the chief employments of men, and the wretched condition of the few existing roads made it necessary to go about on horseback.

Coaches, however, gradually crept into use, though not without a good deal of opposition. A German writer gives the following description of the coaches used by the Emperor Leopold at his wedding, about 1657, or a little later. It will be seen that they were in some points like our coaches of the present day, and were decorated in the same general style: —

"In the imperial coaches no great magnificence was to be seen. They were covered over with red cloth and black nails. The harness was black, and in the whole work there was no gold. The panels were of glass, and on this account they were called the imperial glass coaches. On festivals the harness was ornamented with red silk fringes. The imperial coaches were distinguished only by their having leather traces; but the ladies in the imperial suite were obliged to be contented with carriages the traces of which were made of ropes." A decidedly inferior style was that of the ambassador of Brandenburg, at the election of the Emperor Matthias, in 1612, who, it is reported, had three coaches; but "they were coarse coaches, composed of four boards put together in a clumsy manner." Coarse indeed!

These early coaches had no springs at all, as nearly as can be learned from such representations of them as survive. The leathern straps, which are still used under stage-coach bodies, were the first contrivance of the kind. They are known to have been in use in the time of Louis XIV.

From these lumbering old machines to the assortment of elegant forms and astonishing combinations of strength and lightness, which are to be found in the show-rooms of a first-class carriage maker of the present day, is a very long step. The good qualities of the present style of wheeled carriages are better shown in those of American makers than anywhere else, and the American vehi-

cles are greatly admired abroad. Few of European make reach this country; but when they do, their massive weight and clumsy, blocky structure present a striking contrast to the elastic strength and slender, though enduring, fabric of good American carriage makers' work.

Some of the best examples of American carriage-building are afforded by men who have risen from obscurity and poverty to wealth, success, and reputation by their own energy, industry, and intelligence. Such an instance is that of the extensive carriage warehouse and factory of the firm of William D. Rogers & Co., of Philadelphia, whose history and present condition well illustrate the present attainments of American carriage-making, and the power of the personal qualities just mentioned, in the American business world.

In the year 1846, in a small building belonging to the Girard estate, on the corner of Sixth and Brown Streets, Philadelphia, Mr. Rogers, then a very young man, began the manufacture of coaches and carriages, and laid the foundation of a name which now stands high throughout the United States and a great part of Europe. He employed only seven men at the outset, but being himself a practical coach-builder, as well as an energetic and judicious foreman and manager, it would be hardly an exaggeration to estimate the force employed at several more than seven.

Mr. Rogers remained in this location until 1853, when he erected new shops at the corner of Sixth and Master Streets, and for the first time possessed an establishment in some measure adequate to the rapid increase of his business, and to his own ideas of arrangement and equipment. It is four stories high, covered a space of one hundred and seventy-two by one hundred and thirty-seven feet, and was so completely finished and fitted that it might really have been reckoned, at the time, the model coach shop of America.

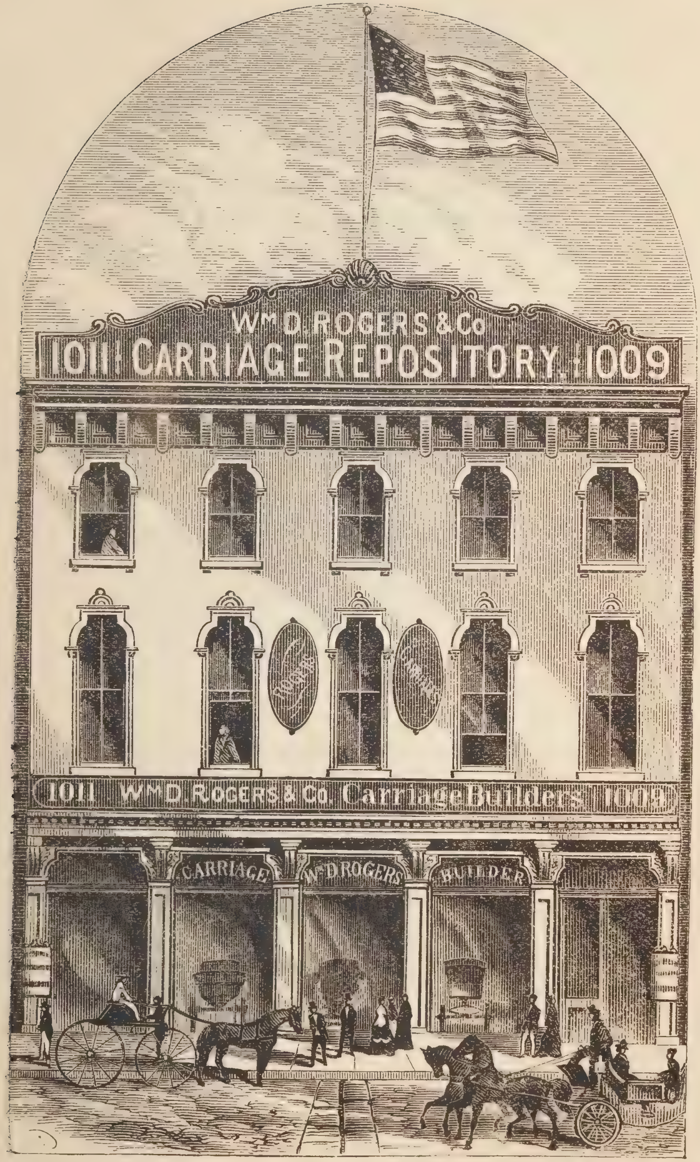
In 1857 Mr. Rogers, having found the office and sales-rooms at the factory insufficient and inconveniently placed, fitted up and opened his present extensive and commodious Bazaar at Nos. 1009 and 1011 Chestnut Street. This enlargement sufficed for a few years, but a large custom trade had by this time grown up, the natural consequence of the durable and tasteful character of the work turned out by the house. As this class of business requires especially close supervision, Mr. Rogers rebuilt the rear portion of the Chestnut Street buildings in 1860, and fitted them up as workshops, in order the more conveniently to oversee them him-

self. More room being still required, a large, four-story building on Filbert Street, directly in rear of the main building, was added in 1865.

The last step in this series of enlargements took place in December, 1870. Mr. Rogers had a little before this time associated in partnership with him Mr. Joseph Moore, Jr., a son of the president of the Bank of Northern Liberties, a young man of financial abilities, executive talent, valuable business connections, and excellent address. Thus re-enforced, and after some months of consideration, the new firm, now William D. Rogers & Co., transferred their principal manufacturing operations to the extensive and commodious premises formerly occupied by George W. Watson & Co., at Thirteenth and Parrish Streets, this firm retiring from business. The new factory was thoroughly remodelled and refitted from office to roof, and is now in full operation, filling the whole of a four-story building one hundred and eighty feet by ninety-five, and there is some expectation that the demands of the business for " more room " will be quiet for a little while at least. The factory and repository are connected by telegraph, — a fact which shows the completeness with which the business is organized.

No single item will give a better idea of the patience and scrupulous care, as well as the important investment of time and money required for such a business as this, than that of the lumber and stock department. The woods used in carriage-making are principally, for bodies, ash, cherry, and poplar ; for wheels and running-gear, hickory. All this must be seasoned during from two to five years before it is fit to be put into first-class work ; and accordingly there must always be stored in the lumber department from two to five years' stock of wood. The quantity thus kept on hand is at least seventy thousand or eighty thousand feet. Nor is this tedious preparatory process confined to rough lumber merely. From one hundred to one hundred and twenty-five sets of wheels are always kept in stock, in order that the additional shrinkage, which always comes after finishing and fitting, shall take place in the shop, thus preventing its appearance during actual service, and rendering the work more durable, besides saving dissatisfaction and bills for repairs.

The chief other departments, of course, are the smith shop, wheel shop, body room, and painting and trimming rooms. These are duplicated in Messrs. Rogers & Co.'s business, each being equally indispensable in the factory and at the Chestnut Street



WM. D. ROGERS & CO'S CARRIAGE REPOSITORY, CHESTNUT ST., PHILADELPHIA.

house. At the former, however, where the main stock of lumber is kept, there is also a saw-mill, run by a steam engine, which furnishes whatever power is needed for any purpose throughout the works. The smith shop consists of a room for jobbing, a room for what is called the "four-spring work," and another for "light work." These contain about twelve forges, and along with them there goes a good deal of room occupied by finished work waiting to be united with carriage bodies, racks for selected iron of all kinds, etc., etc. All the iron-work is made in the shop, except the bolts. The iron used is Norway, Ulster, and Lowmoor iron, the experience of the firm having shown that these are best suited for its work.

The "body room" is really, however, the place where the carriage begins, for here it is that the body of the carriage is made, and from here it goes to the smith shop to be ironed. All the work here is done by hand, from the full-sized drawings furnished by the designer. It then receives one coat of paint, when it goes to be ironed.

A second period of patience and delay comes while the carriage is receiving its glossy coat of color. The care and labor of the process of painting carriages are extraordinary, as it requires eighteen separate coats of paint and varnish before a carriage body is thoroughly finished, each having to be carefully laid on, slowly dried, and laboriously rubbed down — a process which cannot be hurried, and must occupy many days. The work from Rogers & Co. has a reputation for beautiful finish, which may possibly have led to the supposition that some chemical secret is employed. There is nothing of the kind, however, the effect being produced only by the extraordinary care used to maintain an even temperature in the rooms, and to exclude dust. The former object is attained by constant reference to a thermometer, and adjustments accordingly, the latter by having the walls of the finishing room hard finished, painted, and varnished, by having the floor double, and interlined with two separate layers of roof felting, and by having the windows and doors so closely fitted as to be dust-proof. So far does this anxious solicitude extend, that, in order to avoid any unnecessary opening of doors, a small glazed opening is arranged, through which the room can be looked into from without when requisite, without moving the door itself.

The special advance supply of wheels, kept on hand in the wheel department, has been mentioned. This is by no means the

only precaution used, however. The wood itself used in the wheels is selected with the greatest care, and to insure the greatest degree of uniformity and thoroughness in this most important part of the structure, one and the same steady, skilful, and experienced workmen has, for the last nineteen years, driven every spoke used in the factory. The rigid scrupulousness used in the choice of stock for wheels makes their first cost greater than that of a power wheel; but there is no wastage in buying on this principle, and the repairing on the finished work is a minimum, so that the wheels are the cheapest in the end.

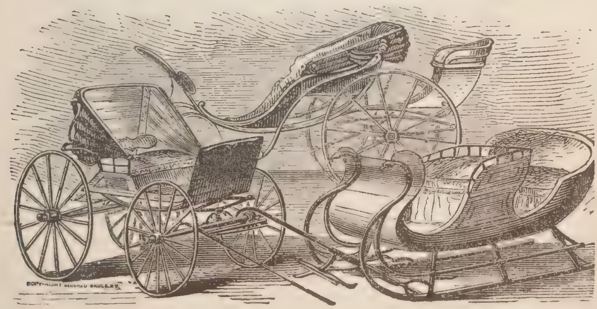
The same thoroughness and care are bestowed on the choice and use of materials in the trimming room, as in all the rest of the work. The leather used, for which the establishment has a special reputation, is made to Messrs. W. D. Rogers & Co.'s own order. The carpets, silks, etc., are mostly imported.

In inspecting the whole of the two portions of this great establishment, it is impossible to avoid being greatly impressed by the extreme thoroughness and completeness with which its departments have been organized, systematized, and arranged with reference to each other, and their remarkable economy of room and fullness of equipment. This secures to every workman the power of accomplishing the greatest quantity of work with the least possible expenditure and waste of time. However, the establishment itself, the obvious excellence of the finished work it turns out, the efficiency, regularity, and ease of all its daily operations, and its great and increasing reputation are all the result of one and the same original motive power — the vivid, wide-awake, inexhaustible, incessant, and close personal supervision and stimulus of its founder. How much such a force amounts to in twenty years may be gathered from a patient examination of this concern. Nor can any intelligent observer pass even a short time in the company of Mr. Rogers himself without being convinced that the force is at least adequate to the result. Mr. Rogers is a compactly and strongly-built man, with abundance of brain, unusually quick motions, keen, bright eyes, a very ready and at the same time a very thoughtful expression, an open, intelligent face, a prompt and pleasant smile — altogether a fine personification of intelligent strength and activity. As might be expected, the conduct of his business is marked at once by liberality, foresight, and kindness, as well as by the strictness and regularity of a mere business man. This is well shown by the fact — one of the highest of all testimonies

— that his workmen remain with him so long; many of them, indeed, began their apprenticeship in the concern, and show no signs of leaving it yet. Nor, after a quarter of a century of labor, does this remarkable "prime mover" relax his oversight. The vigilant supervision of the experienced department foremen, able and constant as it is, is not enough. Mr. Rogers visits the factory daily, and carefully inspects all that is going on in each branch, and during the rest of the day he is on duty at the office and warerooms in Chestnut Street.

No effort has been made by William D. Rogers & Co. to turn out "cheap work." Such work could not pay for the sort of labor and care exercised in their establishment, nor could the mind that habitually exercises such labor and care be satisfied with cheap work. The point aimed at, and reached, has been, by thorough attention to excellence in detail, to secure the utmost excellence in whatever work should be turned out, whether little or much. A proper price has been charged. And the result shows that there are abundance of customers who are better satisfied to pay what is necessary for the sake of obtaining a strong and enduring fabric than to buy at a cheap rate some "rattle-trap" that will cost its original price for repairs within a little while.

Messrs. Rogers & Co. ship their carriages to all parts of America; they have regular patrons in England, France, and Italy, and orders from other foreign countries are from time to time reaching them. What the future of the firm is to be it is useless to conjecture; but it is certain that it has by no means approached the limits of practical and prosperous development.



FISH-HOOKS AND FISHING TACKLE.

EARLY FISH-HOOK MAKERS IN AMERICA. — FISHERIES OF THE PLYMOUTH COLONY. — EARLY MANUFACTURE OF HOOKS IN BOSTON. — THE IMPORTED ARTICLE. — FISH-HOOK MANUFACTURE IN ENGLAND. — HOW THE HOOKS ARE MADE. — FISHING TACKLE IN THE UNITED STATES. — SEINES AND NETS. — RODS AND LINES. — ESSENTIALS FOR THE ANGLER'S APPARATUS. — FLIES AND FLY MAKERS. — THE WONDERFUL FISH HOOK MACHINE. — DR. C. O. CROSBY, THE INVENTOR. — HIS NEEDLE-MAKING MACHINE. — BIOGRAPHICAL SKETCH OF DR. CROSBY. — HIS ROMANTIC AND EVENTFUL LIFE.

THE English Company for the settlement of Virginia sent out, in 1620, among other artisans, both net makers and fish-hook makers — workmen who were much needed in the Plymouth colony four years later, when Winslow complained that the abundant fish in the bays and creeks were almost useless to the colonists for want of seines and fish-hooks. In the list of goods which the Boston merchants agreed not to import during the year 1769, fish-hooks are excepted, showing that the important fishing interest of New England depended upon the foreign supply for tackle.

In 1797, a mill at Dedham, Mass., was engaged in making wire especially for the card and fish-hook makers of Boston, which indicates that the fish-hook manufacture was then carried on to some extent in that city. Yet in 1820, unfinished fish-hooks were largely imported from England, to be finished in this country.

The English fish-hooks, including the Limerick, Kirby, Kendal, and Sneck-bend, are the favorites with fishermen and sportsmen, and the village of Redditch, in Worcestershire, is an important seat of the manufacture. The manufacture of needles is frequently carried on in connection with fish-hook making, both articles requiring nearly the same quality of wire, which should be smoothly drawn, sound, and of the best quality. The manufacture of hooks by hand is simple, but requires dexterous workmen. The wire is cut to the proper lengths, is slit to mark the barb, the end is filed

to a point, the curve is shaped, the upper end is flattened or turned in a ring, to hold the line, and after proper tempering, case-hardening, and bluing, the hooks are finished. With very skilful workmen the processes are comparatively rapid. Hooks for sea fishing are frequently tinned, or are electro-plated with silver, which prevents them from rusting, while the brightness attracts the fish. An improved fish-hook has a swivel in connection with the shank, which by turning prevents twisting the line. The hooks must be stiff, yet elastic — qualities that are secured by proper tempering.

Fish-hooks, though the most essential part, are yet a small part of the aggregate of tackle required for sea, lake, river, and brook fishing. For the sea and river, for certain kinds of fishing, seines of all sizes, some of them thousands of feet in length, must be netted. Nets of all sizes, from large draught nets to the smallest landing nets, are also manufactured. The making of rods is an art requiring both skill and judgment. Salmon rods, of sixteen or eighteen feet in length, are made of maple wood for the butt, ash for the second joint, hickory for the third, and for the fourth, lance wood or bamboo. The reel is made large enough to hold one hundred yards of line. The line is made of intertwisted hair and silk, and is looped to the silk-worm gut which holds the Limerick hook. For brook trout fishing, the tackle manufacturers and dealers supply light rods, suitable lines, reels, hooks, etc., and, as in salmon fishing, a great variety of artificial flies.

For sea and deep-sea fishing, appropriate lines, sinkers, etc., are provided. To give an idea of the variety of manufactures employed in fitting out a fisherman, the following may be mentioned as essentials in an angler's apparatus : —

Rods for salmon and trout fishing, trolling, spinning, fly-fishing, and angling at the bottom ; lines of hair, silk-worm gut, Indian weed, silk and hair, Manilla, and for trolling ; reels ; hooks for trolling, tied on gut, on hair, and loose hooks of all sizes ; sinkers ; tackle for minnows, and various sized baiting needles ; bait boxes, kettles for live bait, landing nets, fishing baskets, pliers, scissors, and penknife, book of artificial flies, book of general tackle.

In what is called a "general rod," the hollow butt contains several tops for the fly, for spinning the minnow, for the float, and for trolling. An almost infinite variety of materials and colors in silks, floss, feathers, etc., go to the manufacture of artificial flies. New York, and most large cities, have fishing tackle dealers, many

of whom are themselves skilful fly-makers, and sportsmen in every locality have their favorite tradesmen with whom they deal exclusively. Some of the New York tackle dealers have attained a great celebrity for their goods among the fishing fraternity.

But fish-hook making and needle making by hand (to which we have alluded as frequently conducted together) have gone into the history of the past, practically speaking. They may for a while yet be continued in some portions of the world. American, or, more properly, "Yankee," ingenuity has distinguished itself by many wonderful triumphs in mechanism, as well as in other fields of science; but though the card making machine, the weaving and the sewing machine, the wonderful automatic loom for the manufacture of hair cloth, and many other curious and deft machines, which seem instinct with life and intelligence, are of Yankee origin, and in active operation to-day, yet the fish-hook machine and the needle machine — the inventions of Dr. C. O. Crosby, of New Haven, Conn., declared by some well versed in wonderful inventions, as "the greatest living inventor" — may be said to surpass them all.

The fish-hook machine is a mechanical problem which English artisans, especially, have long tried to solve. But it was left to Dr. Crosby to accomplish it. To convey to the reader's mind, without illustrating cuts and diagrams, a perfect idea of the machine in operation, would be almost as difficult as to invent the machine itself. But a general and perhaps somewhat satisfactory "notion" of it may be conveyed in words alone. The fish-hooks of various sizes are made from wire drawn to requisite dimensions. This wire is placed upon a reel near the machine, and by the machine (which is automatic throughout) unwound, as the process of manufacture, or, rather, facture, — for there is no hand in it, — demands. Sixty thousand hooks are made by a machine in ten hours. Indeed, sixty-three thousand have been made in one machine in that time, or one hundred and five hooks a minute!

The operator or attendant upon the machine first places the end of the wire on the reel in the fingers of the machine, and has nothing further to do till the wire is all run off from the reel, when he supplies its place with another coil. The cursory observer sees only the wire at one end of the machine being taken from the reel, and the fully formed fish-hooks dropping into a receiver at the other end, at the rate of nearly two a second! But inspection reveals a process which, in general terms, may be de-

scribed as follows: The wire from the reel is unwound to the distance of a half inch, or one, two, or three, or more inches, according to the desired size of the hook to be made, and is clipped off, after passing through a "straightener." The next operation barbs it by means of a chisel, working automatically, and set at the required angle for cutting or slitting the barb, and at the same time the end opposite to that receiving the barb is flattened, or bent into a ring, as the case may be, to prevent the line from slipping off the hook. Next, the barbed wire passes around on revolving dies, whose teeth, formed like the notched spikes of a wheel, catch it and bear it from one operation to another, through shears for cutting or pressing the point, mills for grinding it, and files for further sharpening it, until it is properly smoothed and sharpened, when it passes between rollers which give it the prescribed curve, when it drops into the receiver, a perfect hook, save that it still needs the proper tempering. The machine is so constructed that many pieces of wire are rapidly passing, one after the other, through the machine at the same time, each receiving its special attention at a given part of the process of transformation into a fish-hook.

The process is quite bewildering to the eye of the looker-on, so complex and almost human in its intelligence is the machine. So numerous are the parts of the machine that it requires the most skilful mechanism to combine them for perfect operation. If a single movement of a single part should vary a hair's breadth from its accustomed path, the result would be failure. Yet so scientifically has Dr. Crosby combined the parts of this wonderful creation, that no derangement occurs to the machine, and it works on with wonderful rapidity, with perfect certainty in its operations, making no mistakes. After the hooks are formed, they are passed through the processes of coloring and tempering, these processes being in part the invention of Dr. Crosby, and peculiar to his manufactures. Some kinds of hooks are electro-plated with silver or tin.

The fish-hooks made upon this machine command the American market, and it appears that when made from wire imported from Birmingham, England, upon which duty is also paid, these hooks can be exported and sold in England at a price fifteen per cent. less than the sum for which fish-hooks can be made in England.

The needle machine invented by Dr. Crosby is no less ingenious than the fish-hook machine, and involves perhaps rather more com-

plication of machinery than, but all equally perfect with, that of the fish-hook machine. It occupies comparatively little space for the numerous functions it has to perform, and its operations may be described: First, uncoiling the wire from the reel, next passing it through a straightener, then cutting it off at proper lengths. Thus far advanced towards a needle, the wire passes through three trimming dies which make the point, then goes under three dies which form the eye; then the eye is smoothed by trimming mills. The needle so formed next passes along upon a revolving disk, and its point is trimmed by another set of mills, after which it drops into a receiver, and is ready, with thousands which have preceded it, for inspection, tempering, and polishing. After undergoing a process of polishing of a peculiar kind, the invention of Dr. Crosby, the needles pass through another process by which they are collected in due order and position, and removed in little bundles ready for the papers. Placed upon another machine, the invention also of Dr. Crosby, they are stuck into papers by one motion of the machine. Of course the folding and stamping of the papers, etc., follow, and the needles are ready for the market.

These wonderful machines are only a portion of Dr. Crosby's important inventions. The number of his letters patent is very great — if we are not mistaken, somewhere between one hundred and twenty-five and one hundred and fifty already. Dr. Crosby has been proclaimed, by some of his acquaintances, through the public press, as the greatest of living inventors; and he seems to have already won a place second to none in inventive genius in America. We consider that, in a work like the Great Industries, a biographical sketch of this remarkable man will not be out of place, although he is still living.

Dr. C. O. Crosby (who derived his title of Doctor from his profession of dentistry) was born in Hartford, Conn., in 1817, and is still in the vigor of life. He had but little of any school advantages after his eleventh year. Leaving home at that time, he was employed on the old canal which ran from New Haven to Northampton, in a printing office, in a woollen factory, became a clerk in a store, and served two years with a silversmith. Some misfortune or other caused him to give up silversmithing, and we find him next engaged in the stationery business in New York city. Leaving that he became a clerk in a hardware store, then a clerk in a Broadway jewelry store, and next a dealer in small wares at No. 72 Maiden Lane. He leased a part of the building he there

occupied to John Warren & Co., needle and fish-hook makers, and at this time was it that he began to turn his thoughts to the consideration of a possible machine, some time, for the making of fish-hooks. About the time we last speak of him, we find him appearing at the old Park Theatre in the character of "Sylvester Daggerwood." The next we learn of him, he was in New Orleans, landing there with fifty cents only in his pocket — his whole fortune. There he again figured on the stage. Afterwards he became a clerk in Clinton, Miss. Next, coming north, we find him studying anatomy and physiology in Middletown, Conn., and afterwards dentistry, which he practised in Broadway, New York, for about a year, then setting out on a professional tour through the various states.

The next we hear of Dr. Crosby, he had settled in New Haven, Conn., in the practice of dentistry, which he pursued more or less during twenty years. The doctor has fine business talents as well as inventive genius, and he managed to keep several dentists actively employed for him at times. In the early part of this period of twenty years he invented machinery for making and sticking pins, and engaged in the manufacture of pins at Philadelphia. After two years he returned to New Haven, and shortly after he invented the first machine for sticking pins by steam. This he sold to a gentleman in Waterbury, Conn., for ten thousand dollars, and founded the Oakville Pin Company with a capital of one hundred and seventy-five thousand dollars. The company is still in operation. In Oakville he invented much new and important machinery for use in the business, and obtained several patents therefor. He next went into the manufacture of porcelain teeth, and meeting with success, formed a joint stock company for conducting the business. Subsequently he bought the entire business, and moved it to New Haven. He also rented a store on Broadway, New York, where A. T. Stewart began business, for the sale of his manufactured goods and dentists' materials in general. In charge of this store he placed his brother-in-law, Mr. George Kellogg (an educated and cultivated gentleman, and the father of the distinguished *prima donna*, Miss Clara Louise Kellogg). At the breaking out of the war he discontinued the store, and about this time inventing a ruffle and tape-trimming machine (very important additions to mechanism), he founded the Elm City Ruffle Company, which is still in successful operation, and of which he is president, employing one hundred hands. With this machinery the produc-

tion of goods was facilitated one hundred and fifty per cent. Dr. Crosby obtained six patents in this line of operations.

Afterwards, with his son Charles, who is now secretary of the American Fish-Hook and Needle Company, he went to Europe, and established a factory for the making of teeth near Montmartre, in the vicinity of Paris, which, up to the time of the late revolution, was in operation there, and perhaps still is. Disposing of his business in Paris, he travelled in Europe for eleven months for the purpose of studying the manufacturing interests there. During this time he set in operation a ruffle and tape-trimming factory in London. The business was afterwards transferred to Manchester, where it is now conducted by the house of H. Balfour & Co., who paid him eleven thousand dollars in gold for his ruffle patent. Soon after he invented the tatting machine, by which the production of this article was accelerated two hundred per cent. He sold the patent of this invention to the Elm City Ruffle Company.

Dr. Crosby then reverted in mind to the fish-hook warehouse in New York city. At the time he was doing business at 72 Maiden Lane, nine tenths of the fish-hooks of the world were made in Redditch, England, and entirely by hand. None were made in this country, the low price of labor in England rendering it impossible to manufacture the article profitably in the United States. Dr. Crosby occupied his mind for months in the invention of the machine which we have partially described. This was in 1864. Many attempts had been made by others to effect the same end, but had all resulted in failures. Dr. Crosby obtained patents on this machine in England, France, Prussia, and Russia, as well as in this country, and organized the American Fish-Hook Company, with fifty thousand dollars capital. Soon after he invented the needle machine, of which we have spoken. As was the case with fish-hooks, nearly all the needles in the world were then made in Redditch, England. Now needles made by this machine can be exported to England with profit. Millions of them are made weekly by the American Fish-Hook and Needle Company, which was established with three hundred thousand dollars capital, and with Dr. Crosby as its president.

In 1866 Dr. Crosby again visited England, and established, in Gunn Street, London, a joint stock company for the manufacture of paper and cloth hats, the machinery for making which was, however, the invention of a Mr. Henry Kellogg, of New Haven. In England, Dr. Crosby brought to perfection an invention by

which forty thousand paper boxes can be made in a day, when, before, a thousand was the highest number which it was possible to make in that time.

Of late Dr. Crosby has invented and perfected a boot-making sewing-machine, which is a very remarkable thing. The boot or shoe is put upon a last, the last placed in position, and in less than a minute the inner sole, welt, and upper leather are sewed together. This must revolutionize the shoe-making business by machinery in this country, for our people, now they know they can have it, will have genuine welted work, sewed upon the outside, strong and durable, in preference to the faulty work made without a welt by other machines. A company with a cash capital of one hundred and sixty thousand dollars, called the "Crosby Welted and Turned Sole Sewing Machine Company," has been formed for manufacturing the machines, and is now in operation.

Dr. Crosby has recently perfected, and given practical mechanical expression to, a silk weaving machine, the general invention of another man, and which dispenses with a shuttle, a needle being used instead. This is another great triumph of Dr. Crosby's genius, and must ultimately supersede the old loom. But it is unnecessary to present other evidences of Dr. Crosby's worthiness to be placed in the front rank of American inventors, if not at the head of them all.

Dr. Crosby's genius does not seem to be confined to mechanical inventions. It is said that, so great is his musical talent, he can play upon all kinds of musical instruments readily, requiring no instruction when he encounters a new one. Of late years he has turned his attention to painting, more or less, and has produced a number of most creditable portraits and landscapes. Evidently his mind is one of rare power and activity, and as he is yet in the meridian of life, it is impossible to conjecture what great successes he may not yet add to those which he has already achieved.

LUMBER AND LUMBERING.

THE USE OF THE TERMS. — THE ORGANIZATION OF THE BUSINESS. — A LUMBERING PARTY IN MAINE. — THE SIZE OF THE TREES. — THE WINTER'S CAMP. — GETTING THE LOGS TO THE STREAMS. — FLOATING THEM TO MARKET. — THE DIFFICULTIES AND DANGERS OF THE WORK. — THE SAW-MILL. — CLAPBOARDS. — SHINGLES. — THE EXTENT OF THE BUSINESS. — THE MACHINERY USED IN IT. — THE FUTURE SUPPLY.

In America, *lumber* is the general term for what in England is called *timber*, including beams, joists, boards, plank, shingles, etc. Lumbering (also an Americanism) is the employment of procuring lumber in the forest and preparing it for the market. It is the business of the lumberer to penetrate the virgin forests, occupying himself during a certain portion of the year cutting trees and transporting them to the borders of lakes and rivers, and in the spring floating them to saw-mills or places where the logs are prepared, as square timber, boards, clapboards, and shingles, for a market and the builder.

The lumberer's life in the forest, through the long, cold winters, in the northern parts of the United States and of Canada, is one of great hardship and peril. Generally, before a party of loggers establish their camp for the winter, they send out some of the company to ascertain where the timber is abundant, and nearest the water-courses. Years ago, such a preliminary step was not necessary, as then the giant pines of the North abounded on every side; and in less than half a century it is said that the vast pine forests, through which flow the Penobscot and its tributaries, will no more exist.

When the exploring pa·ty, or the timber hunters, have discovered a promising tract of pines, they examine the quality of the trees, ascertain the distance which the timber must be hauled, and the ground over which the logging roads must be made; these things being satisfactory, they return and make their preparations for a winter's work in the forest. Permits for cutting timber are

obtained from the state or owners of the great forests, at a stipulated price of so much a thousand feet for lumber taken within certain limits. The winter's stores are taken in boats, as near the place selected for procuring lumber as possible, and then transported by oxen, which are to be used in hauling the logs to the water side. Fat pork, the fattest of the fat, is the lumberer's luxury, which, with ship bread and molasses, constitutes the staple of their consumption. "The drippings from a slice of pork, roasted before the fire, are allowed to fall on the hard tack, which is then dignified by the name of buttered toast; sometimes the pork is eaten raw, dipped in molasses" (a mixture which has no equal except raw oysters and brown sugar). On these alone the hungry woodsman makes many a delicious meal, which is proof of the good appetite and digestion of the hardy loggers. But as the lumberers carry their rifles with them, to their usual supplies are occasionally added a partridge, a bear, or a deer. When they have reached their destination with their winter supplies, they select a suitable place for a camp, where they build two log houses, one for themselves and one for their cattle. This work accomplished, they look out and cut open the roads which lead to the principal clumps and groves of pines included in the bounds of the permit. They then commence their regular work of the winter. The largest and fairest pines are cut; the white pine is superior in value and dimensions to all others, though the red pine sometimes rises eighty feet before putting forth a limb. Those who have been on the Penobscot many years ago may doubtless remember having seen trees of extraordinary grandeur and diameter. Specimens cut many years since were reported as more than two hundred and fifty feet long. Said a lumberer, "I have worked in the forests several years, have cut many hundred trees, and seen many thousands, but never found one larger than one I felled on a little stream which empties into Jackson Lake, in Eastern Maine. Its trunk was as straight and handsomely grown as a moulded candle, and measured six feet in diameter four feet from the ground. It was about nine rods in length, or one hundred and forty-four feet, about sixty-five feet of which was free from limbs, and retained its diameter remarkably well. After chopping an hour or so, the mighty giant, the growth of centuries, which had withstood the hurricane, and raised itself in peerless majesty above all around, began to tremble under the strokes of the axe. My heart palpitated as I occasionally raised my eye to its pinnacle to

catch the first indication of its fall. It came down at length with a crash, which seemed to shake a hundred acres, whilst the loud echo rang through the forest, dying away amongst the distant hills. It made five logs, and loaded a six ox team three times. The butt log was so large that the stream did not float it in the spring, and when the drive was taken down we were obliged to leave it behind, much to our regret and loss. At the boom that log would have been worth fifty dollars."

Thus the long winter is occupied in cutting the best timber trees, and as soon as the snows permit, the logs are taken down on to the ice, where they remain till it is broken by the warm spring rains. When the snows melt, and the streams are full, the lumberers break up their camp, and enter on the difficult and dangerous service of driving the logs down the rivers to the abodes of civilization. Many lives are lost in the hazardous occupation of running the logs down the streams. When the rivers are swollen, logs, ice, and boats are borne swiftly down over rocky rapids, sometimes driven on ledges, or made fast on sand banks, and sometimes entangled with fallen trees. When the logs become wedged together in a narrow part of the stream, or among the rocks, they form what are called *jams,* and all motion is suspended. Then the drivers, in applying the axe or the lever to loosen again the huge floating field of tree trunks, are often exposed to great peril. The removal of one log, and sometimes one blow of the axe, sets free acres of timber from their dead lock, and the whole mass moves in tumultuous force down the rapid current. At such times the men are exposed to injury, and not unfrequently lose their lives. When a single log is seen to detain the whole mass, a man is sometimes let down on to the jam by a rope from an adjoining cliff. When a few blows only are given with the axe, the log snaps with a loud report, followed by the violent motion of the jam, and before the bold driver can be drawn to the top of the cliff, hundreds of logs pass in wild confusion beneath him. Other drivers follow the floating mass in boats to set adrift single logs caught by some obstruction in the stream or near the shore, or push them forward when the current has insufficient force to carry them onward. Where streams are large, the logs are formed into rafts, joined together with the limbs of the blue beech, or withes of other tough trees. Sometimes these rafts are nearly an eighth of a mile long, having a number of little huts with masts and sails and ragged streamers, a caboose for cooking, and means for catch-

ing the wind, for steering and anchoring. The raft, in detached portions, is sent over the rapids, and along the timber slides, always with more or less loss or damage to both men and logs.

The loggers in their winter home are often diverted, and sometimes alarmed, by encounters with moose and bears and wolves. In cold weather the bears and wolves become very bold, sometimes accompanying the teams in their journeys between the forest and the rivers to which the logs are taken. The teamsters, though generally brave fellows, are not pleased with such company, and find relief only in making fire-arms a part of their equipage. The lumberer has stories to tell of encounters with catamounts, or "Indian devils," of amusing experiences with bears and their cubs, of the dangerous proximity of the gray wolf, a brute, fierce, strong, and swift, which pursues his prey with pitiless perseverance, following the trail

> "With their long gallop, which can tire
> The hound's deep hate, the hunter's fire."

But attacks of wild beasts in these great forests are not the only trials of these hardy loggers. No time of their stay in the woods is exempt from peril. Wounds are accidentally received from the axe; limbs torn from falling trees, and branches broken by them from other trees, made brittle by intense frost, flying in all directions, threaten injury and endanger life. Their career is all hardship and danger, while their occupation is of immense importance in the lumber trade.

At the saw-mills the logs are transformed into all kinds of lumber for building purposes. Since the introduction of the steam engine, the business of sawing has become independent in some degree of water power, and mills are established in the most convenient places for receiving supplies of timber. Railways are now made to penetrate the forest, carrying the heavy machinery of the steam saw-mill, and returning with car loads of lumber ready for the market.

Among the kinds of lumber are clapboards, also called weather boards, about one half an inch thick at one edge, and nearly sharp at the other. They are cut from the log by very ingenious machinery. A white pine log, cut at the proper length, is turned in a lathe to a diameter a little more than twice the width of the clapboard. This log is then placed on a frame, and carried by machinery against a circular saw, which cuts it from end to end

nearly to the centre. The frame then returns over the saw, which continues to revolve in the kerf it had made; the log then turns on its axis just the distance of the thick edge of the clapboard, when it again moves forward, the saw cutting another kerf; the same movements are repeated till the log is cut entirely into clapboards, the thick edges being on the outer circle, and the sharp edges meeting in the centre of the log. The manufacture of shingles is also an important branch of the lumber business. The work is sometimes carried on in the forests. The logs are cut into the length of a shingle, and then split into several pieces called *bolts*. These again are split by means of a long blade struck with a mallet, and then shaved down to the form and thinness required. Another kind, called sawed shingles, are made by machinery constructed for the purpose. The bolt is fastened in a frame, and is set against the saw for either the thick or thin end of the shingle. The saw runs through the bolt, cutting off a shingle, and by the self-acting movement of the frame, the saw commences again with the thickness belonging to the opposite end of the next shingle. They are thus made with great rapidity, the thick or thin end of successive shingles being taken alternately from opposite ends of the bolt. The attendant straightens the edges immediately, by passing them over a plane iron fixed in the machine.

The immense extent of the lumber business may be inferred from the fact, that more than ten thousand men have been engaged year after year in logging and sawing on the Penobscot River alone. There are vast pine forests about the head waters of the Hudson, the Susquehanna, Delaware, and Alleghany Rivers, in New York and Pennsylvania. Michigan and Wisconsin also have very extensive pine forests. The annual value of lumber and shingles in Wisconsin is now more than ten million dollars. Immense forests of good timber clothe the Cascade and Coast ranges of mountains in Oregon. Lumbering establishments are located on the Columbia River, and at points on the coast, where inlets, bays, and arms of the sea provide safe anchorage for small craft, and where the forests are easy of access from navigable waters. The timber adapted to general lumbering purposes are the red, white, and yellow fir, cedar, spruce, and hemlock, also pine and larch. The cities and coast valleys of California, being destitute of timber, rely on the saw-mills of Oregon and Washington Territory for building, fencing, bridge, wharf, and ship timber. Besides home

markets for Oregon lumber, it is sent to the seaports of Mexico, South America, Sandwich Islands, China, Japan, and Australia. Cargoes of lumber have been shipped from the Columbia River to New York and Liverpool with profit.

Extensive lumbering establishments are now in operation on the southern boundary of Oregon. Three large mills there have a joint capacity of seventy-five thousand feet of miscellaneous lumber every ten hours when in running order. They are all driven by steam. They produce about twenty million feet annually. At Portland there are three mills having a joint capacity of forty-five thousand feet in ten hours. The machinery consists of the ordinary double circular, edgers, trimmers, lath saws, slab saws, and the necessary planing and dressing machines to meet the wants of the market for dressed lumber. All are driven by steam power.

By the Congressional Report for 1869, it appears that the saw-mills of the Columbia, like those of other places in Oregon and Washington Territory, using both water and steam power, manufacture and send to market every year a large quantity of lumber of every kind. The sloping hill-sides for a distance of a hundred miles are clothed with a dense growth, to the water's edge, of all kinds of timber common to the North-west coast. Experienced lumbermen estimate that the timber within one mile of the navigable waters of the Columbia River, suitable for saw-logs, cannot be exhausted by the saw-mill force now in operation during the present generation. A hundred thousand feet of lumber have been taken from an acre of ground, and it is not uncommon for six to eight thousand feet to be taken from a single tree.

In view of the approaching scarcity of lumber in what have been hitherto regarded as good timber countries, the great resources in the vast forests of Oregon and Washington Territory give promise of an abundant supply for many years, probably for many generations.

POTTERY AND PORCELAIN.

THE EARLY DISCOVERY OF THE ART. — THE EGYPTIAN TRADITION THAT IT WAS DIVINELY TAUGHT. — THE ART AMONG OTHER NATIONS OF ANTIQUITY. — THE CHINESE AND JAPANESE. — THE DISTINCTION BETWEEN POTTERY AND PORCELAIN. — ETRUSCAN AND GRECIAN VASES. — THE PORTLAND VASE. — JOSIAH WEDGEWOOD. — THE NATIVES OF PERU AS POTTERS. — THE RENAISSANCE OF THE ART OF POTTERY IN EUROPE. — THE DELFT WARE OF THE DUTCH. — THE ESTABLISHMENT OF SOME OF THE FAMOUS MANUFACTORIES OF EUROPE. — THE INTRODUCTION OF THE POTTERS' ART AMONG THE AMERICAN COLONIES. — THE INTRODUCTION OF PORCELAIN. — THE NECESSITY FOR SCIENTIFIC KNOWLEDGE AND ARTISTIC TRAINING IN THIS BUSINESS. — THE PROSPECTS OF THE FUTURE.

ONE of the earliest arts attained by mankind was that of making pottery. The Egyptians themselves had, in the time of Herodotus, who lived and wrote nearly five hundred years before Christ, so lost the knowledge of when they first became acquainted with this art, that they, as is usual with a semi-civilized people, ascribed its origin to the teaching of some divinity.

In Egypt, the Hebrews were kept at making brick, and in their escape from the land of bondage they unquestionably carried with them the knowledge of this art and its allied manufacture of pottery. The frequent use in the Old Testament of the terms taken from this industry, and the numerous cases in which figures are drawn from articles of pottery, show, if such a proof were needed, that the manufacture was well established among the Jews, and that domestic articles of pottery were in very common use.

In the East, utensils are often made of pottery, of a size so large that we would hardly think of making them from any material less strong than wood or metal. In the story of the Forty Thieves, in the *Arabian Nights*, the robbers conceal themselves in jars. Reading this, as a child, the writer was struck with the evident absurdity of a man's concealing himself in such a sized jar as are usually seen in this country. The consistency of the story becomes plainly evident, however, when first the jars in use in the East for storing oil or wine are seen. These are frequently almost as high

as a man, and, being proportionately broad, would afford most handy and convenient places for concealment.

While the knowledge of pottery was so widely diffused among the nations of antiquity, yet the Chinese and Japanese are the only nations who seem to have had any knowledge, long ago, of the art of making porcelain; and by both of these nations this art was carried, at an early period, to the high pitch of perfection which their products of this kind still hold. The distinction between the products of these two processes is evident to every person with the least habit of observation. Pottery is made from baked clay; and though sometimes glazed, yet it is always opaque, — while porcelain, though its chief ingredient is the same substance, yet it is mixed with some fusible material which, combining with the infusible clay, results in making a semi-translucent substance, which is afterwards glazed, and otherwise decorated.

Of each of these substances, of either pottery or porcelain, there are several varieties, which differ from each other by small, oftentimes by almost imperceptible, distinctions or grades, but all of which can still be classed under one or the other of these heads. These distinctions arise from the various proportions in which the ingredients are mixed, or from the various processes they undergo in the manufacture, the degree of heat to which they are subjected, its continuance, or to some other cause.

Among the ancients, the most celebrated manufactories of pottery were those of the Greeks, and the Etruscans, who were settled in Italy before the Romans dominated that country, and who derived their methods and style of decoration of their vases from the Greeks, either by way of commercial intercourse with Greece, or directly by the settlement of Grecian artists among themselves.

When we reflect how very fragile this pottery ware is, it seems surprising that the immense quantities of it now gathered in the various museums of Europe should have been preserved so long, and through the various accidents of war which have characterized the history of the rise and destruction of the various nations of Europe during the period of modern history. But its preservation is accounted for when we reflect that it was the custom of the nations of antiquity to bury, frequently, numbers of these vases and other vessels in the tombs of their dead; and that even to-day, in the recent excavations, numerous specimens are still found. These vases and other vessels are frequently decorated with figures, and

form the most valuable data for the study of the customs, the costume, and the manners of the extinct races who made them.

One of the most valuable and celebrated of these vases is that known as the Barberini or Portland vase; the original of which now forms one of the chief treasures of the British Museum. It is a vase about fifteen inches high. It is covered with a thin covering of a beautiful dark blue, upon which the figures are raised in white. Fifty copies of it were made by Wedgewood, the famous manufacturer of ornamental pottery and porcelain, which were sold to subscribers at ten guineas each. Though this did not reimburse Wedgewood for the expense of making these copies, yet it was in doing this that he discovered a method for imitating the charming color and the perfect surface of this kind of ware, for which his factory afterwards became so famous, and the secret for the composition of which is still preserved by his descendants.

To give anything like a description of the remains of ancient pottery which have come down to us, or of the knowledge gained from their study of the manners of the people, is impossible, — since to do so would be to condense an entire literature into the compass of a few lines. Among the number of works upon the subject we will mention, however, only Birch's *History of Ancient Pottery* as most readily within the reach of those desirous of pursuing the subject further.

In China, the manufacture of porcelain first supplied the demands of Europe, so that the name "china" has become the term in ordinary use for our cups and plates. The Chinese themselves ascribe the invention of pottery to the Emperor Hoang-ti in 2700 B. C., and that of porcelain to the year 185 B. C. Porcelain in China is used not only for domestic but also for architectural purposes. M. Stanislas Julien, a distinguished French scholar of the Chinese language, has translated into French a Chinese history of the manufacture of porcelain, from which much information can be gained, not only by the general reader, but also by those practically engaged in the manufacture themselves.

Among the ancient inhabitants of Peru and some other countries of South America, pottery had, at the advent of the Spaniards, attained quite a development. In their almost total destruction of the civilization which they found flourishing in these countries the Spaniards did not spare the evidences of this art. But with the inquiring spirit of modern times, and the new desire to study and preserve the remaining records of the past history of man's actions

upon this planet, the subject of the proficiency of the South American nations in the arts has excited its share of attention, and exceedingly interesting collections of their pottery have been made. One of the best of these is in possession of the New York Historical Society, and is there open to the inspection of the public.

The pottery made in Peru to-day is far inferior in finish and decoration to that made before the Spaniards brought their degenerating civilization there. Ewbank, in his *Life in Brazil*, gives illustrations of some of the ancient pottery vessels which have been preserved, and calls attention to some of the forms now in traditional use there, as worthy of imitation by other more advanced nations. He speaks especially of the jug made for keeping water, which is called a "monkey." This is made as a closed vessel, with two spouts; a larger one for pouring out the water, and a smaller one for admitting the necessary supply of air. The texture of this vessel is made porous, so that the outside surface is kept constantly moist by the exudation of the water, while the rest of the contents are thus cooled by the evaporation of this moisture from the outside of the vessel.

With the overthrow of the Roman Empire the art of making decorative pottery disappeared from Europe, but was first brought back into Spain by the Arabs when they obtained a foothold in that country, in the eighth century, and into Sicily in the next century. From this last point the art spread into Italy, and during the fourteenth and fifteenth centuries reached a high state of development. During this time flourished the manufactories of majolica ware, so called, it is supposed, from the fact that the Moors had made a ware somewhat similar, in the island of Majorca. To the decoration of this ware distinguished artists devoted themselves, and Raphael is supposed to have prepared the designs for some of the pieces, such as large platters and other vessels. So artistically was this ware decorated, and such a wealth of ornament was lavished upon it, that its original intention for domestic use was lost sight of entirely, and the plates, the cups, the vases, and other vessels, came to be valued and used only as luxuries of decoration.

In the fifteenth century the Dutch, who, from their commercial relations with Japan, had been chiefly instrumental in introducing Japanese ware into Europe, commenced the manufacture of glazed pottery ware, which was extensively used in Europe. It was known as Delft ware, from the fact of its being manufactured in and near this place.

The manufactory of porcelain was introduced into Saxony in 1709, by Böttcher, who had by experiment succeeded in inventing a genuine white porcelain. The elector, Frederic Augustus, was so pleased with it that he established at Weissen a factory for its production, placing Böttcher at the head of it. This was the origin of the manufacture of Dresden china, which is still successfully carried on, and is still so highly valued.

In 1720 and 1751 the works were established at Vienna and at Dresden, which are still in operation. In 1735 similar establishments were put in operation in Chantilly, France; in 1745 at Vincennes, and in 1754 at Sêvres, at which the famous Sêvres china is made. These royal manufactories, inaugurated under royal patronage, were of course for the production chiefly of wares for royal consumption. While it is of course desirable and advantageous to improve any branch of industry, and to experiment in improved methods and processes of manufacture, without being restrained by the practical question "will it pay?" yet still industrial enterprises founded and conducted upon these principles can hardly be counted among a nation's industries. They are in the practical struggle for life which characterizes the intense action of the social forces of to-day, what greenhouse culture is to the practical agriculture of to-day.

There is no objection, in fact there may be a positive advantage, in having some rich men raise strawberries in January by a system of forcing-houses, or cultivate pineapples under glass, at an expense of a dollar for each berry, or ten dollars for each pineapple. The successful results of such experiments show at least what human energy and science can attain, and when carefully and judiciously done, they may add valuable material to our stock of knowledge, but, as agricultural experiments, they certainly have but small effect in cheapening the food of nations. The rich man may congratulate himself upon the cheapness of his strawberries at fifty dollars a plate, and find that he gets more satisfaction from squandering a portion of his superfluity in this way than in some other display of extravagant luxury, and perhaps he may be right; but certainly he cannot lay any claim to have provided fruit for the million, or to have raised the standard of the supply of food for the poor.

The enterprises undertaken to attain this object must be conceived in a different spirit and carried on by a different method. A workman in the manufactory at Sêvres has done a good day's work when he has made from fifteen to twenty plates in a day; but in the

same time an English potter, with the aid of two boys, makes from one thousand to twelve hundred plates, while an American, by the aid of improved appliances, increases even this production, and of necessity cheapens their cost in the same ratio, and thus enlarges the field for their consumption. A national industry must look to the people for the purchasers of its products, and with the people the question of cost is of the first importance.

The manufacturer who has been chiefly instrumental in England in so cheapening earthenware and porcelain as to have inaugurated the present almost universal use of this ware was Josiah Wedgewood, who has already been mentioned. Those of us who have not yet reached the Psalmist's term of life can remember the time when a china or earthenware plate was a luxury. In the kitchens and dining-rooms of New England, some fifty years ago, the housewife was proud of her store of pewter, and the well-polished platters of this material occupied then the shelves now filled with earthenware.

The chief pottery manufactories of England are in Staffordshire, and occupy the same spots in which pottery was made during the Roman occupation of England. Here at Barslem, a little town, Josiah Wedgewood was born in 1730. When he was about thirty he commenced the manufacture of a peculiar cream-colored ware, which became very popular under the name of "Queen's ware." This title was given to it by the fact that Queen Charlotte was gracious enough to accept a present from him of some sets of it, and conferred on their maker the title of "Queen's Potter." The business so increased that in 1859 the exportations of pottery from Staffordshire amounted in value to nearly thirteen millions of dollars, while this industry supports over sixty thousand operatives in a territory of about ten square miles.

Among the first settlers of this country in Virginia, potters are mentioned, and in *A Perfect Description of Virginia*, published in 1649, they are enumerated among the tradesmen who lived well there and gained much by their labor and art. The Indians found here by the colonists had themselves a rude knowledge of pottery, and used the clay common in the country for making their pipes, although they do not appear to have carried the art much further.

The Dutch in their settlement of New York and the adjacent country very soon introduced the making of pottery, and some of the ware made during their possession of the territory, in Long Island, was said by contemporary authorities, quoted in O'Calligan's

New Netherlands, to have been not inferior to that made in Delft. Other manufactories of pottery ware were established in the various colonies, and the art was so well understood, that, if the natural location of the materials required offered the opportunity, every new settlement made for itself the pottery needed for its own consumption; so that in 1790, Hamilton, in his report as Secretary of the Treasury, mentions pottery ware as one of the most considerable branches of industry throughout the country, and as having come the nearest towards supplying the demand.

Within this century the manufacture of porcelain has been introduced into this country, and has become an important industry. An extensive bed of kaoline or decomposed felspar was discovered in 1810, at Monkton, in Addison County, Vt., and a company was organized for the purpose of making porcelain from it. Other beds of the same material were also discovered at other localities in the State, and elsewhere, and the business began to attract more attention. In 1819 the manufacture of fine porcelain was commenced in New York, from domestic materials, by Dr. H. Mead. In 1827 William Ellis Tucker, whose warehouse was situated at 40 North Fifth Street, in Philadelphia, had brought the manufacture of china or porcelain to an extensive and successful point of development; and in this year the business was commenced near Pittsburg, where clay of a suitable character was discovered by a company of English potters, who had come over for the purpose. A porcelain-factory was also in successful operation at this time in Jersey City, near New York, employing about one hundred operatives, and working with a capital of two hundred thousand dollars.

In Chester County, Penn., a fine bed of kaoline was worked up by Mr. Tucker, who has already been mentioned, who, in 1825, began the first factory in this country of American queen's ware, and who, by successive steps of improvement, had succeeded in producing wares which, for coloring, gilding, and other decorations, were claimed to be second only to those of France. With others, he formed the American Porcelain Company, and after his death the undertaking was carried on by Thomas Hemphill.

Up to the present time the business has steadily increased until the value of the pottery and stoneware, by the census of 1860, reached a total of nearly three millions of dollars, and, by the last census, of over five millions of dollars, while the porcelain ware produced was valued at over a million and a half. Nor has the advance been characterized only by the increasing quantity produced to

satisfy the increased demand, but also by increasing artistic skill in the decoration and in the forms used.

The necessity in the modern world for a scientific and artistic education of those practically engaged in such industrial pursuits as call for the display of knowledge and art is shown as much in the production of porcelain as in any industrial employment, and has been more fully recognized in England than in this country. The various industrial exhibitions of Europe showed the manufacturers of England so conclusively the commercial value of scientific knowledge and artistic training in the competition for supplying the demand for wares displaying these qualities, in the increasing culture of modern times, that they interested themselves in affording the opportunity for obtaining these; and the result has been the establishment of the Kensington Art Museum, with its series of practical schools, the effect of whose teachings has been already most marked by raising the artistic standard of various departments of English manufactures.

In this country, as yet, the necessity for the general diffusion of artistic and scientific education has not been so fully realized as to have given rise to any practical steps for its organization; but the subject is exciting attention, and the contemporaneous propositions in New York, Boston, Baltimore, and other cities, for the establishment of art museums, in combination with practical scientific and artistic schools, is full of promise for the future that our artistic culture will keep pace with our industrial progress.

CARPETS.

THE ORIGIN OF CARPETS IN THE EAST. — THE NATURAL REASONS FOR THEIR USE IN WARM COUNTRIES. — THE MAGICAL PROPERTIES ASCRIBED TO CARPETS IN THE EAST. — CARPETS AMONG THE EGYPTIANS. — THE PERSIAN CARPETS. — CARPETS AMONG THE GREEKS AND ROMANS. — THE INTRODUCTION OF CARPETS IN EUROPE. — HOUSES AT THE TIME OF QUEEN ELIZABETH. — CARPETS IN FRANCE. — THE FIRST CARPET IN THE UNITED STATES. — THE COMMENCEMENT OF THEIR MANUFACTURE. — ERASTUS B. BIGELOW. — THE PROBABLE FUTURE OF CARPETS.

According to the best authorities, the manufacture and use of carpets originated in the East. It was but natural that this should be so. The domestic customs of the people, their mode of sitting or reclining upon the floor, instead, as we do, upon chairs or couches raised above it, made the necessity for some covering for the floor more apparent; and as necessity is the mother of invention, carpets, or, as we should rather call them, rugs, were always, and are still, one of the chief articles of domestic wealth in the East.

The open-air life so common to the nations of the East was also another cause for their use of carpets. Reclining as they do under the shade of trees, lying sheltered from the sun in the cool shadow of their gardens, and at the close of the day seeking the fresh evening air upon the house tops, the necessity for some texture upon which to recline must early have been met by carpets. The importance attached to the carpet in the East is shown by the stories in the *Arabian Nights*, ascribing magical powers to it. To the wonders of fairy-land it is what the railroad and telegraph are to modern science. By it time and space were annihilated, and the fortunate possessor of one of these wonderful fabrics had only to seat himself upon it and wish to be transported to any distant spot, to find himself there. In fact, the carpet plays a role in every phase of Eastern life, and it is as impossible to separate the idea

of a Persian, a Turk, or a Hindoo from his carpet, as it is to separate a Frenchman from his *café*, or an Englishman from his umbrella.

Among the Egyptians, the Babylonians, and the Assyrians, the use of embroidered carpets and of woven hangings was equally common, and they carried the art of their decoration to a high point of perfection, while each of these nations, as in their architecture, and all their decorative industry, displayed in the patterns of their carpets peculiarities which make the style of each of them distinct and easily recognized from every other. In Persia, from the earliest times, their carpets have been distinguished for their patterns, made by a combination of simple, bright colors, put together apparently without any definite method, and in irregular forms, but which are really arranged with an instinctive eye to harmony of effect, and so successfully managed that they have all over the East, and in Europe also, a high value.

Among the Hebrews, carpets and hangings were in frequent use. In *Exodus*, the directions given for the hangings of the tabernacle and the court "of blue, and purple, and scarlet, and fine twilled linen wrought with needle-work," show conclusively that the art of decorating and adorning fabrics of this kind had even then reached a point of high development.

In Greece, the use of carpets as coverings for the floor is mentioned by Homer, and the web of embroidery which Penelope was engaged on every day, and ravelled every night, so as to keep the suitors for her hand at bay until the return of her faithful Ulysses, was intended to serve either as a hanging for the walls or as a covering for the couch or for the floor. At the banquets of the Greeks, and of the Romans, who obtained most of their luxuries from imitation of the Greeks, the use of splendidly embroidered coverings for the couches upon which the guests reclined was carried to a pitch of wasteful extravagance. No material was considered too precious or costly for this use. Gold, silver, and precious stones were used in profusion to decorate fabrics made of silk, of velvet, of the finest cashmere wools, or of camel's hair.

In Europe, the use of carpets is of comparatively quite recent date, and though their manufacture by the improved machinery of modern times has so cheapened their cost as to put them within the reach of many, yet they are by no means considered as indispensable an article of household necessity as they are here in the United States. In this respect, as with the ballot, and the personal responsibility of the people in the government, the United

States have made rights and luxuries universal, which in the old world are confined to the privileged classes.

The use of costly and elaborate tapestries for the decoration of the walls was common in the palaces of Europe, while the floors were either bare or covered with rushes—a kind of grass much resembling our rank meadow hay. Even as late as the time of Queen Elizabeth, the floors of the royal presence chamber were covered with rushes, and luxury in this respect was a daily renewal of this covering. This daily change of fresh straw was brought as a charge of inordinate luxury of living against Thomas á Becket. The filth which was allowed in these "good old times" to accumulate upon the floors, even in the palaces and houses of the rich, we can hardly conceive to-day. Erasmus, in his letters, speaks of the dampness and moisture thus kept in the houses, and how prevalent fevers, colds, and diseases of all kinds are made by living in such an atmosphere. The rushes, or hay, thus strewed over the floor, were often allowed to remain until they rotted, while the scraps of meat and food from the tables, the mud from the shoes, and the dust which the careful housewife of to-day removes so carefully once or twice a day, were allowed to remain until they became the actual hot-beds for disease.

It is by no means a pleasant picture which Erasmus gives of such a floor, over which the dogs fought for the scraps and bones they found, while the fleas and other insects, thus disturbed, attacked in their turn the legs of the guests. In fact, there is but little doubt that the comparative freedom of modern times from the plagues and pestilences which periodically visited the society of those days, is caused by our habits of greater personal cleanliness, and the attention given to public and private sanitary conditions.

It seems the more singular that the use of carpets should have been delayed so long in England, when we reflect that the manufacture and use of tapestry were quite general at a very early period. One of the most interesting and historically valuable pieces of the tapestry work of this early period is that known as the Bayeaux tapestry, which was made in the time of William the Conqueror, under the direction of Queen Matilda, by herself and the ladies of her court. The design of this most elaborate piece of work is to represent, in various pictures, the conquest of England. This piece of work is in seventy-two divisions, is twenty inches in height, and two hundred and fourteen feet long. Each

of the divisions contains pictures of scenes illustrative of the conquest of England by the Normans, and they are singularly valuable as correct representations of the costumes and manners of the times. This tapestry is now the property of the town of Bayeaux, in France.

As early as the reign of Henry VIII. an attempt was made to introduce into England the manufacture of tapestry upon a large scale. Before this date England depended chiefly for its supplies upon the Low Countries. Bruges, Antwerp, and Arras, — from which last the term *arras*, for tapestry, as used by Shakespeare, was derived, — together with Brussels, and other cities furnished the chief supplies. This first attempt was unsuccessful; but in 1609 a manufactory was established at Mortlake, in Surrey, to which James I. contributed a subscription of nearly three thousand pounds. The business, however, increased slowly, but attention began to be directed to it, and in 1757 the Society of Arts awarded a prize for the best imitation of Turkey carpets to their secretary, Mr. Moore, who had induced some Huguenot refugees from France to devote themselves to this branch of manufacture. Now England manufactures carpets which are used all over the world.

In France the manufacture of carpets was begun as early as the reign of Henry IV., but, as in England, the first attempt was not entirely successful. In 1664, Colbert, the great minister of Louis XIV., to whose personal interest France was indebted for the introduction of so many new branches of industry, established at Beauvais, an ancient town situated about forty miles north-west of Paris, a manufactory of carpets and tapestry, which is still in operation, and is still classed as second only to that of Gobelins. This manufactory, which was also established by Colbert as one of the "royal manufactories of the furniture of the crown," is still acknowledged universally to be the leader of the world in the production of carpets as objects of luxury. None of them are sold, but they are all used either for the decoration of royal palaces, or as presents to other royal houses. The weaving is all done by hand, and, as the designs are chiefly copies of famous masterpieces of painting, the work necessarily requires more artistic than simply mechanical ability for its execution, and is both costly and slow. A square yard is considered a fair result of a year's work, and the value of such a piece is about seven hundred dollars. The largest single piece of work ever made here was a

carpet for the Louvre, which measured about thirteen hundred feet in length, and was composed of seventy-two separate pieces.

In the United States, it is traditionally reported that the first carpet ever used in a private house was one found in that of Captain William Kidd, the famous pirate, who was executed in 1701. This was probably some small Eastern rug, which he had taken from some one of his prizes. From the files of New York papers of the year 1760 advertisements have been culled, showing that Scotch and other carpets had been offered for sale there by merchants engaged in importing from the mother country. Yet until after the revolution their use was very limited. The rag carpet, of strictly domestic make, and the sanded floor, satisfied the demands for comfort or fashion made by the mothers of the republic. The production, however, of rag carpets had become considerable, in order to prepare the way for the establishment, in 1791, of a carpet factory in Philadelphia by William Peter Sprague. Mr. Sprague called the products of his factory Turkey and Axminster carpets, and wove one of them, in which the design was the arms of the United States, with figures emblematical of its achievements.

In his report as Secretary of the Treasury, Alexander Hamilton, in 1791, recommended that the duty of five per cent. upon imported carpets should be increased by two and a half per cent., as a further protection to this branch of home industry. The census of 1810 returned nine thousand nine hundred and eighty-four yards of carpetings and coverlets as the amount of that year's production in the United States. Of this, seven thousand five hundred and one yards were made in Philadelphia, at a valuation of about a dollar a yard, and seven hundred and fifty yards in Harford County, Maryland, at some little over three dollars a yard.

Up to this time, however, the weaving of carpets, both in this country and in England, had been done entirely by hand. American invention had been turned in the direction of improving the looms in ordinary use, and before 1840 several patents had been granted for looms to weave carpets, but even then only carpets of the simplest kinds. The problem of making a power loom which should automatically perform so apparently difficult a task as to weave a two-ply web, so as to produce any required pattern, had in England been abandoned as insolvable. It was, however, solved by Mr. Erastus B. Bigelow, of Massachusetts, who also invented a loom for the manufacture of Brussels carpets. His improved

loom, by which figures were produced which would match, was patented in 1845.

By the introduction of these looms in manufactories in Massachusetts and Connecticut, carpets were so greatly cheapened as to be brought within the reach of almost every one, and would be so now were it not for the working of our tariff, which so enhances the cost of all the materials used in their production, that the business of carpet manufacture is, of necessity, nearly abandoned.

Besides carpets of wool, straw carpets, imported generally from the East, are largely used, on account of the fresh and cool air they give to a room in summer. Carpets of hemp were also introduced a few years ago, but the rapidity with which they wore out has caused their almost total abandonment. Carpets are also made of canvas painted, known as oil cloth, and an imitation of this, made of painted paper, is also largely used. The so general use of carpets was a necessity some few years ago from the fact that the floors of our houses were generally built of such poor material, and in such a shiftless manner, that the floor was too unsightly to be left exposed. Within a short time, however, with greater attention paid to the construction of our floors, having them properly laid in narrow boards, which are accurately fitted, and then stained and oiled, the carpet has become again reduced to its proper position — as a covering to the floor, instead of being a concealer of its defects. A room thus furnished, with a well-made floor, upon which a carpet with a border is laid, is kept clean so much easier, and looks so much better than one of the old style, where necessity required that the carpet should fill every corner, that there is no doubt of its general acceptance. The fashion of our carpets will then change, and no carpet will appear well unless it has a suitable border, and a pattern which is not a fragment, but complete in itself.

STEAM FIRE ENGINES.

THE USE OF STEAM FIRE ENGINES AN INSTANCE OF PROGRESS. — THE FIRST STEAM FIRE ENGINE. — THE FIRST ENGINE IN NEW YORK. — THE INTRODUCTION OF STEAM FIRE ENGINES IN CINCINNATI. — COMPETITIVE TRIAL IN BOSTON, MASS. — THE BUTTON ENGINE WORKS. — THE MERITS OF THE STEAM FIRE ENGINES MADE BY THEM. — A DESCRIPTION OF THEIR SIZES AND STYLES. — THE METHOD OF THEIR CONSTRUCTION. — THEIR ADVANTAGES. — THE DEMAND FOR THEM.

There is hardly any better instance of the progress which civilization, during this century, has made in using the forces of nature, for purposes of its own benefit, than the introduction of the steam fire engine. To thus make fire the means for subduing itself is a very striking evidence of how the increasing knowledge of mankind has slowly prepared the materials for our domination of Nature, and led us to a recognition of the fact that Nature's forces are not our enemies, but our friends, if we only know how to use them properly.

Elsewhere in this volume, under the head of Fire Department Supplies, a sketch has been given of the growth of our appliances for subduing fires, and the improvements in our methods for mastering a conflagration. Of these the chief is the steam fire engine. Though the first attempt to introduce the use of steam as the motive force for throwing a stream of water from a fire engine was made in England, yet the perfection of steam fire engines and their general adoption have been more thoroughly reached in the United States than in any other country.

The first steam fire engine was built in London, in 1830, by Mr. Braithwaite. It weighed over five thousand pounds, was of about six horse power, generated steam in about twenty minutes, and could send about one hundred and fifty gallons of water a minute from eighty to ninety feet high. The boiler was upright. The steam and water pistons were placed at opposite ends of the same

piston-rod, the stroke of each being sixteen inches, and their diameters seven and a half and six inches respectively. The clumsiness of the apparatus, and the length of the time necessary to get up steam, were the chief objections made to this first steam fire engine. The entire feasibility, however, of the idea of making steam fire engines was settled by it beyond question, and the attention of inventors, as well as that of the public, was turned into the direction of so improving them as to remove the objectionable features of this first attempt, and to replace the cumbersome and inadequate use of hand engines for the extinguishing of fires by the more efficacious and handy use of steam engines.

In 1841 an engine was built in New York, at the expense of the combined fire insurance companies of that city, by Mr. Hodges, which performed good service upon several occasions at fires in that metropolis. It was a very powerful steam fire engine, but its extreme weight made it so difficult to handle readily that it was finally sold to be applied to other purposes.

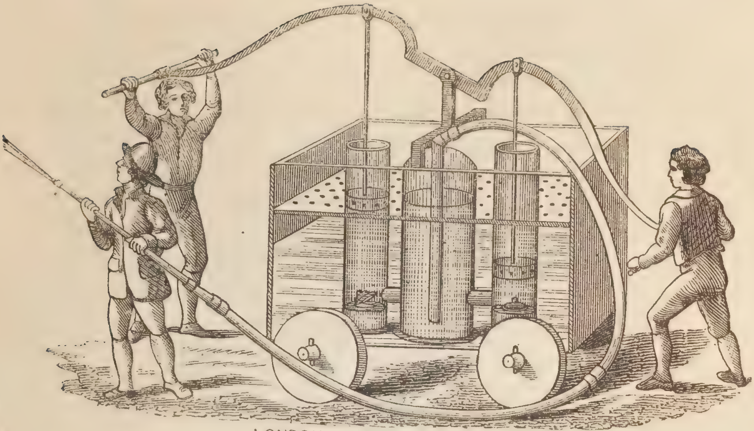
In 1852 the city of Cincinnati, having resolved to organize its fire department upon the basis of steam fire engines, and thus obtain at once the greater efficiency from their use, and also to do away with the evils incident to a volunteer fire department, had an engine constructed by Mr. A. B. Latta, which was finished in the early part of the next year. In this engine the steam was used as a partial aid to its propulsion, but its great weight — nearly twelve tons — necessitated also the use of four strong horses to drag it. Other lighter ones were built the next year, and finally all idea of using steam in propelling the steam fire engines has been done away with by the best constructors.

The first of these engines built by Cincinnati was peculiar in the method of its construction. It had a square fire-box, like that of a locomotive boiler, with a furnace open at the top, upon which was placed the chimney. The upper part of the furnace was occupied by a continuous coil of tubes opening into the steam chamber above, while the lower end was carried through the fire-box, and connected outside with a force-pump, by which the water was to be forced continually through the tubes throughout the entire coil. When the fire was commenced the tubes were empty, but when they became sufficiently heated the force-pump was worked by hand, and water forced into them, generating steam, which was almost instantly produced from the contact of the water with the hot pipes. Until sufficient steam was generated to work the en-

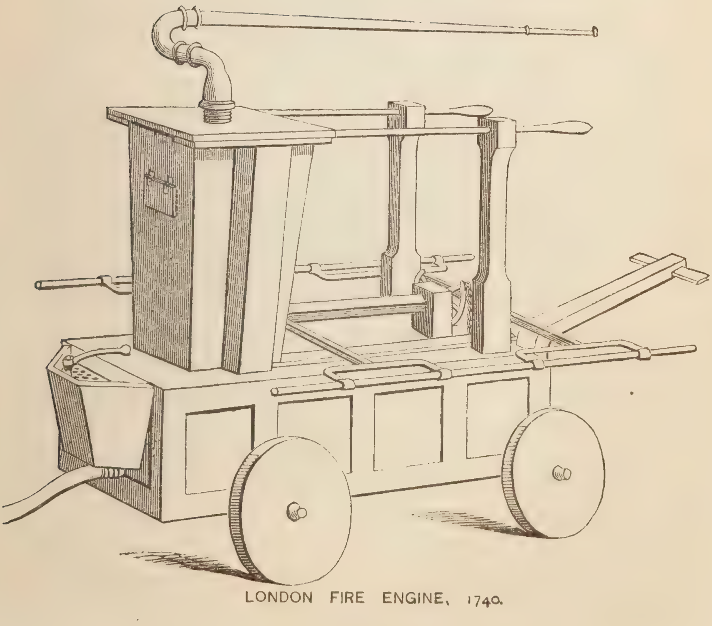
gine regularly, the force-pump was continuously operated by hand, and a supply of water kept up. By this means the time occupied in generating steam was only from five to ten minutes; but the objections to thus heating the pipes empty and then introducing water into them are too well known to be insisted upon here.

The engines made upon this pattern were complicated and heavy, but were efficacious, and led to their introduction in other cities, and also to a quite general establishment in cities of a paid fire department in place of the voluntary one, which had theretofore prevailed. The lightest steam fire engine constructed upon this method weighed about ten thousand pounds. It was carried to New York upon exhibition, and upon a trial there threw, in 1858, about three hundred and seventy-five gallons a minute, playing about two hundred and thirty-seven feet, through a nozzle measuring an inch and a quarter, and getting its water supply from a hydrant. The same engine is said to have played in Cincinnati two hundred and ten feet, through a thousand feet of hose, getting its water supply from a cistern.

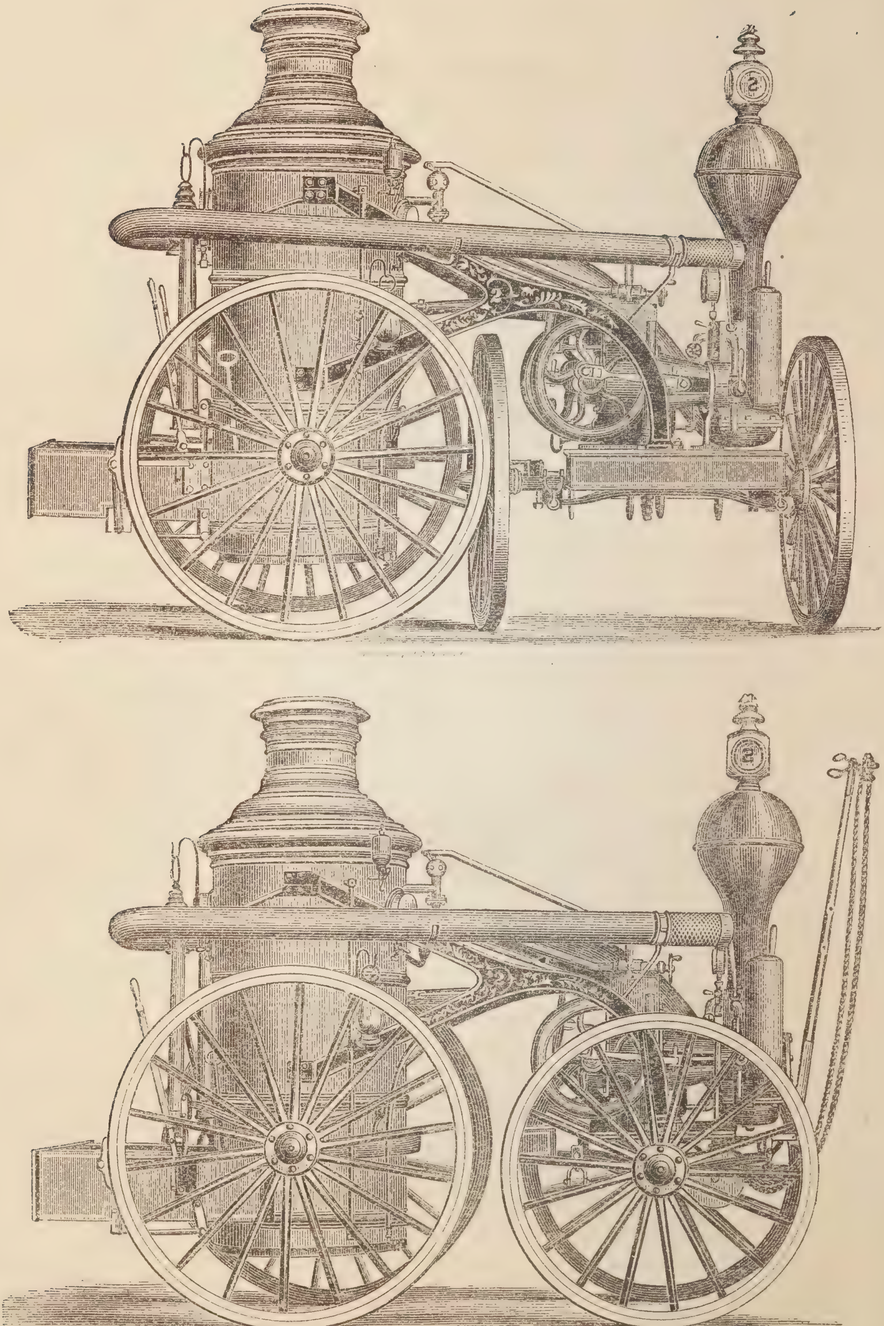
In 1858 there was a competitive trial of steam fire engines at Boston, Mass., the city authorities having offered a premium for the engine which should be proved the best. In the trial there were four engines entered the list: The Philadelphia, which was built in that city by Messrs. Rainey, Neafie & Co.; the Lawrence, built at the Lawrence Machine Shop, in Lawrence, Mass.; the Elisha Smith, built by Messrs. Bird & Co., of East Boston; and the New Era, built by Messrs. Hinckley & Drury, of Boston. In the order in which these are here named they weighed 7455 pounds, 7300, 9330, and 9415. Charged with water they weighed respectively, in the same order, 8055, 7870, 9866, and 9915 pounds. In raising steam from cold water to sixty pounds' pressure, they took respectively eleven minutes eight seconds, ten minutes twenty-nine and a half seconds, thirteen minutes fifty-one seconds, and eighteen minutes twenty-one seconds. Their capacity was, in the same order, three hundred and six, three hundred and two and a half, three hundred and nine, and three hundred and forty-five gallons a minute; their horizontal distance, playing an inch and a quarter pipe, was one hundred and sixty-three, one hundred and fifty-four and a half, one hundred and forty, and one hundred and thirty-five feet. Their vertical throw was one hundred and ten, one hundred and ten, one hundred and twenty-five, and ninety feet.



LONDON FIRE ENGINE, 1765.



LONDON FIRE ENGINE, 1740.



STEAM FIRE ENGINES, MANUFACTURED BY L. BUTTON & SON.

All of these engines had upright tubular boilers, with reciprocating steam pumps. Their general principles were the same, their differences being simply in the special devices used in their individual construction. The pressure of steam used in the trial was limited to one hundred and twenty pounds — a condition which operated unfavorably to the Lawrence, which was constructed to work most advantageously at a higher pressure. Under the conditions prescribed for the trial, the Philadelphia was declared the victor, but the Lawrence was purchased by the city of Boston, and placed on duty.

This trial did much to call attention to the superiority of steam fire engines, and various improvements were introduced into the methods of their construction by different inventors and manufacturers, for the purpose of attaining greater lightness and efficiency in their working.

The improvements which have been made in the construction of steam fire engines, and the point of perfection at which this new industry has arrived in the short course of the thirty or forty years during which the idea of their practical use has been in the world, can be made to best appear by a description of the steam fire engines manufactured by the Button Engine Works, situated at Waterford, Saratoga Co., N. Y.

The founder of these works, Mr. L. Button, has been so intimately connected with the improvements in the hand engines, which preceded the use of the steam fire engine, as well as with those of these last, that he deserves even a more extended biographical notice than our space will permit. Commencing his industrial career without any adventitious aids of education, he entered a machine shop in 1825, at the age of sixteen, and by persistent application after his day's work was over, acquired a thorough knowledge of arithmetic, surveying, navigation, natural philosophy, and astronomy. Becoming the foreman of an engine machine shop in 1833, he was made a partner the next year. Turning his attention to the improvement of the hand fire engines, which were then in use, in 1838 Mr. Button produced the first "piano engine," which delivered the water from the front end of the trunk, or box. In 1841 he made the first pump for a fire engine, with valves at an angle of about 45°, and straight level water-ways from the inlet to the outlet. In the same year he made the first engine with folding brakes and a vacuum chamber. In 1842 he made the first engine with a slotted or grooved walking beam or cross bar, by means

of which the leverage on the pump could be shortened or lengthened, and the capacity of the engine changed, without altering the travel of the brakes. In 1848 he made the first engine with the suction hose always attached, and carried in what is called the "squirrel tail" style; and the same year he made the first "crane neck" side stroke engine with large forward wheels to turn under the frame.

By these various successive improvements the reputation of the Button engines was assured. At a competitive exhibition of hand fire engines in Hartford, Conn., in 1857, thirty-six engines competed for eight prizes. Among them were eight Button engines, five of which took prizes, each engine being limited to a single prize.

With the advent of the steam fire engine, Mr. Button, about eight years ago, turned his attention to their manufacture, and with the advantage acquired by the firm from their long and successful attention to the requirements of the fire department, took immediately a leading position in their manufacture, which has been maintained by them ever since; the steam fire engines made by Button & Son being universally recognized as combining a greater variety of excellences in design, construction, and efficiency than those of any other make.

In 1834 it was estimated that there were in use in the United States about five hundred fire engines; since that date the Button engine works have made and sold about seven hundred engines — an evidence of the public appreciation of their excellence which is conclusive. It is estimated that at present there are in use in the United States about three thousand five hundred fire engines of all kinds, about one thousand of which are steam fire engines, and that in the manufacture of these, and fire apparatus of all kinds, there is a capital employed of about $2,000,000.

Our illustrations represent a Button engine in a side view, and also with the forward wheels turned at right angles, showing the arrangement of the works upon the truck, which enables the engine to turn round in its length. These engines are made of three sizes, weighing respectively four thousand, five thousand, and six thousand pounds.

The boilers are upright and tubular. The tubes are made of copper, since tubes of this material do not corrode, and will last as long as the rest of the boiler, and longer than iron tubes, which would be worn out in about three years. In the engines of the

smallest size there are two hundred tubes, one and a quarter inches in diameter, and in the largest four hundred and twenty of the same dimensions. The boilers, when finished, are tested under a pressure of two hundred and twenty pounds to the square inch, and thus far in their experience no boiler made by Messrs. Button & Son has failed in any way to fulfil the requirements. Indeed, it is believed that they would stand a pressure twice as great as that to which they are subjected in the test. The working pressure of a steam fire engine is properly about eighty pounds, and with this an engine weighing four thousand pounds will throw a stream from a pipe measuring one and an eighth inches in diameter two hundred and twenty-five feet.

The engine proper constitutes no part of the frame and running gear, but is built entirely separate, and then securely fixed in its place by suitable braces. Consequently no undue strain or jar, produced by running over rough pavements, can possibly affect the machinery. The steam cylinder and pump are preserved in their relative positions by a casting forming a head for each. The crank-shaft and balance-wheels, together with the valve-gear, are also made a part of the back head of the steam cylinder. This ingenious arrangement is the joint invention of Messrs. Button & Son, and is patented. Its advantage is twofold, since the two cylinders are thus placed and held in perfect line with each other, and in the second place a greater strength and rigidity are thus attained. The chief necessity for having the cylinders placed in a perfect right line is plainly apparent when we remember that the slightest deviation from such a line causes a friction against the pistons and piston-rods, which greatly decreases the efficiency of the engine.

With these engines, manufactured by Messrs. Button & Son, only five pounds of steam are necessary for drawing and throwing the water, while with twenty pounds of steam they will draw water and throw it, through two hundred and fifty feet of hose, to a vertical height of ninety feet. This was the result attained in a trial before a committee of impartial and competent scientific engineers. A similar successful performance has never been made by any other class of steam fire engines.

The steam pump used in these engines, manufactured by Button & Son, is a very powerful one, and is comprised within the small circle of four feet in its extreme diameter, which enables the engine to be turned within its length, as shown in the cut. The pump is balanced upon the fore wheels of the truck, while the

boiler is balanced on the hind wheels. The fore and hind wheels are placed at the proper distances from each other, and are kept in place by only a light crane-neck frame of iron. This arrangement of balancing, in connection with the peculiar adjustment of the crane-neck, is the invention of Button & Son, and is patented. The obviously great advantage of this arrangement is the dispensing of the "reach," which is always an obstruction to the rapid handling of a steam fire engine, while at the same time it so secures the safety and durability of the engine that a frame, under which the forward wheels can readily and easily turn, is an achievement in the art of their mechanical construction which may be said to be the chief improvement made in the model of a steam fire engine, and to have chiefly contributed to Messrs. Button & Son's eminent success in taking the lead in this special branch of manufacture.

Every one who is practically acquainted with the working of steam fire engines will recognize how much this ability to handle the engine readily and easily contributes to the quickness of getting into position, and will thus see its importance. The delay in doing this is often the waste of the most important time, when the fire is getting under such headway as to be beyond control.

The cranks, shafts, and piston-rods of these engines are made of Bessemer steel, the best steel for the bearings or stuffing-boxes, since it is much stiffer than iron of the same size. The water cylinder of these engines, the pump of which is called a "plunger," is so constructed that, when the necessary piston-packing wears out, it may be speedily and accurately "set up," or tightened, instead of the pumps being taken apart and repacked — an important consideration, since this process of "setting up" requires less than five minutes, while "repacking," in any other engine, requires at least half a day.

In these engines every moving joint, bearing, or packing is so made that it can be at once set up or adjusted in case of any wear. No metal is used in these engines which can corrode, Messrs. Button & Son mixing their own metal, and using none that is old, so that their composition possesses a wonderful tenacity and malleability, while every portion of the work, during every stage of its progress, is carefully inspected.

The boilers are jacketed with Russia iron; the steam cylinders are covered with brass, and the water cylinder is made of bronze. All the working parts are of polished steel or iron. The smallest

NEW YORK FIRE ENGINE, 1730.

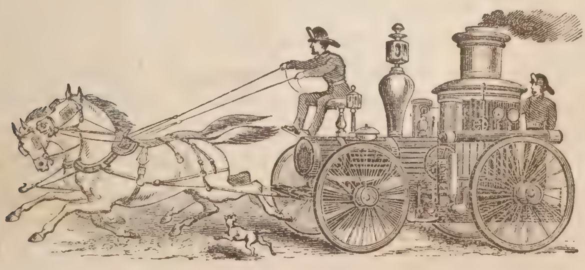
NEW YORK FIRE ENGINE, 1733.

sized engine, weighing four thousand pounds, will throw two hundred and twenty-five feet, through a one and one eighth inch pipe; the best result ever attained by a hand engine, being one hundred feet horizontally, by an "end stroke" engine. The next size, weighing five thousand pounds, will throw two hundred and fifty feet; and the largest size, weighing six thousand pounds, will throw two hundred and sixty-five feet, through a one and one fourth inch pipe. These engines are single, the general objection of oscillation, which is usually sought to be guarded against by making the engines double, being obviated by a simple device in their construction.

Besides their simplicity and effectiveness, Messrs. Button & Son are able by the organization of their business, and by devoting it to this specialty, to furnish these engines cheaper than has formerly been done, and by this means have so extended the demand for them that numbers have been sent as far as Canada.

As a means of comparing the advance made in modern times in the appliances for extinguishing fires, besides the engravings of the steam fire engines manufactured by Messrs. Button & Son, we present our readers with others of the engines formerly in use. One of these engravings represents an engine used in London in 1740, and the other a London fire engine of 1765. Besides these there are engravings representing the engines used in New York for extinguishing fires in 1730 and in 1733.

For the use of these engravings, which are interesting as showing also the styles of building in use at the time, we are indebted to the kindness of the *Insurance Monitor*, of New York city, in which journal they first appeared as illustrations of an admirable history of the fire engine from the earliest times, and to which those of our readers who are interested in this matter are referred for a more comprehensive and exhaustive treatise upon this subject than would evidently be possible in a work of the character of this.



BRITANNIA WARE.

THE MATERIALS USED FOR MAKING THE EARLIEST DOMESTIC UTENSILS. — THE INVENTION OF POTTERY. — THE USE OF METALS. — THE EARLY TABLE CUSTOMS OF ENGLAND. — QUOTATIONS FROM EARLY ENGLISH LITERATURE. — THE DERIVATION OF THE WORD "TRENCHER." — THE DOMESTIC UTENSILS OF THE EARLY COLONISTS IN THIS COUNTRY. — THE INVENTION OF BABBITT METAL. — IMPROVED FORMS OF DOMESTIC UTENSILS. — THE INTRODUCTION OF MACHINERY INTO THIS BRANCH OF MANUFACTURE. — THE EXTENT OF THE MANUFACTURE.

THE making of dishes, pitchers, cups, and the various other necessary utensils for domestic use, was one of the first steps in the progress of mankind towards civilization. The earliest utensils of this kind used were, most probably, shells among the nations who lived upon the seaboard, and leaves among those who lived where the forests afforded them of a kind adapted to this purpose.

The invention of pottery was, however, one of the earliest arts discovered by mankind, and the refuse heaps of fragments of vessels made of clay, and baked, are still remaining on the banks of the Nile, and in other sites, forming the most suggestive, and, in many cases, the only remaining, record of nations which have long ago passed away.

In modern times the succession of the various materials employed for articles of domestic use serves to mark the successive steps of society towards the attainment of universal comfort and luxury. With the ability to work in metals, this stronger material has replaced the fragile pottery, until luxury is to-day satisfied with nothing but the most precious substances, and gold and silver have replaced the use of the more modest pewter and brass with which our ancestors were forced to be content.

In the early times, in England, it was quite the custom, as much from the greater scarcity of articles of table furniture as from the freer domestic manners of the time, for two persons to eat out of the same plate; and it was with persons tenderly attached to each other a manifestation of gallant attention to thus combine at table.

This practice is frequently alluded to in the early romances and fabliaux. In general, the disposition of the guests about the tables was not left simply to chance, but those who were in love with each other, or were nearly related, were placed together. In the poem *La Male Sanz Frain*, the lady of the castle makes Sir Gawain sit by her side, and eat out of the same plate with her, as an expression of gallant and friendly hospitality.

In the fabliau of *Trubert*, a lady taken into the household of a duke is given a seat at table next to the duke's daughter, and eats with her from the same plate, because that young lady had conceived a strongly affectionate feeling for her visitor. In the *Gesta Romanorum*, an earl and his son dine together at the Emperor's table, and are served with a fish, which is placed between them upon a plate which serves for both. So general was this custom that it passed into language, and "to eat from the same dish" became expressive of a strong friendship between two persons.

In his *History of Domestic Manners and Sentiments*, Mr. Wright says: "It must have been remarked that, in the illuminations of contemporary manuscripts which represent dinner scenes, the guests are rarely represented as eating on plates. In fact, only certain articles were served in plates. Loaves were made of a secondary quality of flour, and these were first pared and then cut into thick slices, which are called, in French, *tranchoirs*, and in English *trenchers*, because they were to be carved upon. The portions of meat were served to the guests on these *tranchoirs*, and they cut it upon these as they ate it. The gravy, of course, went into the bread, which the guest sometimes, perhaps always, at an earlier period, ate after the meat; but in later times, and at the tables of the great, it appears to have been more frequently sent away to the alms-basket, from which the leavings of the table were distributed to the poor at the gate."

This custom is alluded to quite frequently in the writings of this time. In the romance of *Sir Tristrem*, we read:—

> The kyng no seyd no more,
> Bot cresche and yede (went) to mete;
> Bud thai pard and scohre (cut),
> Ynough thai hadde at ete.

For the rulers of the time a silver platter was often placed under the *tranchoir*, and most probably it was thus that, with the abandoning of the *tranchoirs*, the platters came to be used alone. The general use of silver as the material for platters was of course im-

possible from its cost; and iron was the material used for the poor. Pewter, however, replaced this, since it was a cleaner and handsomer material.

In the colonial times in this country, and even until into this century, wooden dishes and pewter platters were used almost entirely. The grandmothers of the present generation took as great a pride in a plenteous store of pewter dishes as any of their descendants now take in the gold and silver ware which garnishes their sideboards; and the brilliancy with which it was kept polished was as much an evidence of the possession, on the part of the lady of the house, of thrifty housekeeping qualities, as anything to-day can be.

It is quite within this century that china and porcelain have come into general use. The pewter was not replaced by them immediately; but with increasing knowledge in the chemistry of metal-working other materials than pewter began to take its place. About 1825, Mr. Isaac Babbitt, of Taunton, Mass., invented the mixture which is known by the name of the Babbitt metal, and commenced with it the manufacture of Britannia ware. This was the initiative of a business which has grown to great importance in the United States.

The fashion and form of the various domestic utensils have been modified and improved to suit the more fastidious taste of the present day, and the culture which is sensitive to artistic merit in all of its surroundings can find the materials for its gratification in the various utensils now produced in such quantities by the leading manufacturers of Britannia ware, and at such low rates as to place them within the reach of every one.

The unconscious but persistent educational effects of our surroundings are thus made almost universal, instead of being the privilege of only a favored few; and the culture which comfort brings necessarily with it is thus slowly but surely preparing the way for the progress of the nation towards a higher and broader civilization, in which the artistic shall keep pace with the industrial advance of the nation, and the moral effects of the happiness which arises from the gratification (not the crucifixion) of our desires be made the basis of our social organization.

The value of the Britannia ware produced in the United States now reaches many millions of dollars yearly, and embraces the most extensive variety of utensils, while the quality of the material employed has undergone an equal improvement.

SCREWS.

THE INVENTION OF THE SCREW. — AN EXPLANATION OF THE SCREW. — MALE AND FEMALE SCREWS. — HUNTER'S SCREW. — MICROMETER SCREWS. — THE INTRODUCTION OF MACHINERY IN THE MAKING OF SCREWS. — THE FIRST MACHINE PATENTED IN THE UNITED STATES FOR MAKING SCREWS. — OTHER MACHINES INVENTED. — IMPROVEMENTS IN THE FORM OF THE SCREW. — THE GIMLET-POINTED SCREW. — ITS PROBABLE ACCEPTANCE BY CONSUMERS.

The invention of the screw is generally attributed to Archimedes, a philosopher of Syracuse, who flourished during the latter part of the third century before the Christian era. It is, however, most probable that the practical use of screws was known before his time, but that to him the credit belongs of having first classified the screw as one of the mechanical powers, and from the study of the laws regulating its action deduced the rule for calculating its efficiency.

A screw is evidently a special application of the inclined plane, and is made by the spiral revolution of an inclined plane about a fixed axis. Cut a piece of paper into the form of a right-angled triangle, the perpendicular side of which is of the length of the screw to be made, and the hypothenuse will represent an inclined plane. By simply winding this piece of paper about any object, as, for example, an ordinary lead pencil, the line of the hypothenuse will ascend in a spiral curve from the point to the top and represent the threads of a screw.

From the fact that the screw is a modification of the inclined plane, the method of its mechanical action is the same, and the power of the screw depends upon the ratio between the distance apart of the threads compared with the diameter of the circle they make in their revolution. As in practical mechanical applications the screw is generally combined with the lever, of course the power exerted is increased by the length of the lever, since the circle described by the power applied is increased by this distance.

The general division of screws is into male and female screws; the male screw being one in which the threads project upon the cylindrical body of the screw, and the female screw one in which

channels are cut for the reception of these threads. In the nuts and bolts in ordinary use, the bolts afford instances of the male, and the nuts instances of the female screws.

A combination of the male and female screw, in which great increase of power is gained, is that known as Hunter's screw. In this arrangement, a screw working in a fixed nut is made hollow, with a female screw in the inside, along which a screw with finer threads works. The power exerted is as the difference in the distance between the threads of the two screws. While, of course, the power exerted by this arrangement is greatly increased, yet from the law of mechanics, that a gain in power is obtained by an expenditure of time, the motion produced is so small that this arrangement is not much used except when great weights are to be moved only small distances. The jack-screws which are used for raising houses or moving great weights are instances of one of the modifications of the Hunter screw.

This property, however, by which a considerable motion in the power is reduced to a very small motion in the weight, makes this combination of screws of great service in the manufacture of the philosophical instruments and in the accurate measurement of modern scientific research. By the use of micrometer screws, as they are called when devoted to such purposes, distances which are almost infinitesimal are measured with the greatest accuracy. With the microscope, objects wholly invisible to the naked eye are exactly measured to the many thousandth part of an inch.

The uses of screws in the various branches of modern industry are as innumerable as the variety of their sizes; ranging from the jack-screws, strong enough to raise enormous burdens, to those used in watch-making, which have to be applied with the microscope in order to enable the operator to see them with sufficient distinctness to discriminate which is the head and which the point.

The cutting of screws was, in early times, the chief difficulty in the way of their extensive production and use. As the process was then carried on entirely by hand, and required skill in making them with the desired accuracy, screws were too expensive to enter into very general consumption. With the advent, however, of the modern era of industry, in which the idea of the application of machinery to the various processes of manufacture, which forms so distinctive a characteristic of modern methods compared with those of antiquity, came to be practically applied, various attempts to produce screws by machinery were made.

Soon after the formation of the Union of the States, and the establishment of a national system of patent rights, David Wilkinson, of Rhode Island, about 1794, applied for a patent for a machine for cutting screws. In 1789, Samuel Briggs, of Philadelphia, memorialized the Legislature of Pennsylvania and the General Congress on the subject of a machine for making nails, screws, and gimlets. In 1809, Abel Stowell, of Worcester, Mass., took out a patent for a machine for cutting screws; and in the same year Ezra l'Hommedieu, of Saybrook, Conn., patented a double-podded screw auger, and later in the year informed the Secretary of the Treasury that he made wire for himself, from which a man, aided by two boys, could make, by a process of his own, three hundred pounds a day of assorted screws, which were better than the imported ones, and that in his opinion in a short time the demand of the United States would be supplied by screws produced by his simple and cheap process.

In 1811, a machine for cutting screws was patented by Edward W. Carr, of Philadelphia, and put into operation by him in that city. In 1812, a patent for another machine for cutting screws was granted to E. Hazzard and Joseph White, of Philadelphia. In 1813, six patents were granted various parties for improvements in making screws by machinery. One of these was to Jacob Perkins, of Newburyport, Mass., for manufacturing the shanks of screws, and two others to Abel Stowell, of Worcester, Mass., for making and finishing the heads. In 1817, Phineas Dow and Daniel Treadwell, of Boston, Mass., patented a machine for making screws, which, from a coil of wire, cut, headed, grooved, polished, and finished screws at the rate of ten a minute, requiring only to be supplied with the wire, and have the end given to it.

In 1827, Lemuel W. Wright, of London, England, the inventor of a pin-machine, patented in this country a machine for making screws, which he had patented in England the year before. It was a considerably complex machine, and was superseded. In 1834, screws were first made by machinery at Providence, R. I., where the New England Screw Company, and another devoted to the same branch of manufacture, were organized within a few years, and commenced the production for which Providence has been distinguished up to the present time.

In 1852, four patents, and in 1856 four more, were issued to Cullen Whipple for improvements in making screws. These were assigned by him to the New England Screw Company.

Not only have improvements been made in the machines for the production of screws, but also in the shape and method of constructing the screw itself. One of the chief of these is the introduction of the gimlet-pointed screw, which has almost entirely replaced the old-fashioned form of the screw ending in a blunt point. It seems singular that so simple an improvement as this, which is nothing but combining the screw point of the gimlet, which was formerly needed for making the hole in which the screw was afterwards placed, with the screw itself, should have been only so recently made; but any one who is aware of the slow course of improvement, both industrially and intellectually, which has heretofore necessarily marked the course of human advancement, from the want of a method which should scientifically direct the efforts of the human mind in these directions, and co-ordinate into a consistent system the scattered individual efforts towards the attainment of the means for producing the required ends which have so frequently proved abortive on account of their isolation, will not be surprised at it. The history of industry, among its numerous instances of this, affords perhaps none which is more striking than the above. Screws and gimlets had both been long in use before the idea of combining them together, simple as the idea seems, occurred to any one of the thousands daily engaged in practically using both of these implements, and this, too, when the gimlet itself was nothing but a pointed screw. And this is the more singular when we know that in France gimlet-pointed screws were made more than a hundred years ago, but, from the want of a simple change in the machinery used for making them, did not possess the accuracy needed for bringing them into general use.

The manufacture of the gimlet-pointed screws is chiefly done by the American Screw Company, of Providence, R. I., which is a consolidation of various New England companies formerly engaged in the manufacture of screws, and which controls their productions by the ownership of nearly fifty various patents for improvements in the processes of their manufacture, and by their consequently exclusive use of the best machines yet in use for this purpose.

The machines employed by this company are marvels of ingenious construction, and perform with rapidity and accuracy operations which would appear impossible to be performed by any other agency than skilled and intelligent manipulation.

The wire from which they are made is furnished in coils, and is

first dipped into acids, then annealed, and then drawn into the proper thickness. A machine then cuts the prepared wire into the required lengths, and cuts the heads of the shanks, at the rate of about ninety a minute. Then another machine shapes the heads of the screw, cuts the groove, and removes the burr. Then in another machine the threads are cut, and the gimlet point formed, at the rate of about five a minute. Then they are counted out by weight and prepared for sale.

The value of the screws produced by this company exceeds a million of dollars a year, and consists of about five million gross of screws, in the making of which over three thousand tons of iron are consumed, the chippings and trimmings from which amount to about three tons a day.

Another improvement in the method of making screws consists in the arrangement of the threads about the central cylinder. This invention was made by Mr. Samuel Pratt, who is at present a resident of Hammonton, New Jersey. This screw differs from the ordinary screw in having three threads, which revolve about the core only once and a half in their passage from the top to the point, instead of having, as in the ordinary screw, only one thread which revolves many times in the same distance. The advantage of having the threads revolve at this angle lies in the fact that a screw so constructed can be driven in with a hammer, instead of requiring a screw-driver. Under the blows of the hammer the screw in its passage through the wood revolves. Beside these merits, the simplicity of its construction renders it possible to manufacture them at a cheaper rate than other screws, and as the threads are further apart, and take a stronger hold upon the wood, it holds with nearly double the strength of an ordinary screw. With large bolts, such as are used for securing large timbers, — as, for instance, those of a ship, — the advantage of screws of this kind is very great. The patent for their manufacture has passed into the hands of a corporation, with a capital of two millions of dollars, the chief of whose establishments is at Northampton, Mass.

Although not yet as generally in use as the ordinary gimlet-pointed screw, from the recent date of their introduction, yet there is but little question that their superior claims to attention will be recognized in time by those who are interested in such matters.

LIFE INSURANCE.

THE DEFINITION OF SOCIAL PROGRESS. — THE RESULTS OF SELFISHNESS. — INSURANCE AMONG THE ANCIENTS. — THE COMMENCEMENT OF LIFE INSURANCE. — INSURANCE DURING THE CRUSADES. — ANNUITIES. — TONTINES. — THE ROYAL TONTINE. — SYDNEY SMITH ON THE DISTRIBUTION OF SALARIES IN THE CHURCH OF ENGLAND. — PASCAL. — DE WIT. — THE CENSUS. — PARISH REGISTERS. — JOHN SMART. — THE BILLS OF MORTALITY. — JOHN GRAUNT. — SIR WILLIAM PETTY. — THE BRESLAU TABLES. — DR. HALLEY. — THE CARLISLE TABLES. — LIFE INSURANCE IN THE UNITED STATES. — ITS CHARACTERISTICS. — THE PHŒNIX MUTUAL LIFE INSURANCE COMPANY. — ITS ASSETS. — ITS GROWTH. — ITS STABILITY. — THE PRINCIPLES UPON WHICH IT IS CONDUCTED.

The introduction and progress of the principle of insurance in modern times is one of the most striking instances of the tendency of social organization, which has been stated concisely by various social philosophers as the replacing of individualism by altruism, or the extension of personal selfishness until it embraces a world-wide sympathy, and by an increase of knowledge, grows to see that not isolation, but union, is the means for obtaining the conditions of security and regularity which are necessary for individual as well as social improvement and progress.

In this commercial phase of civilization, which is at the present time the characteristic of our social life, it is too usual for those who judge of social matters sentimentally rather than logically, and through their feelings rather than through their reason, to speak of the selfish desire for personal aggrandizement as the cause of the discords evident in the struggle for existence, which seems to grow more intense with every extension of our culture, and every increase in its demands for gratification.

But, in reality, personal selfishness — that is, the imperious demand for the gratification of our desires — is the motive force of all individual or social progress. It is the educated enlargement of selfishness which is needed, and not a hopeless and futile at-

tempt to eradicate it. The very intensity of the commercial spirit, directed and stimulated by increasing knowledge, has, together with other things which distinguish the organization of our present social methods from those of all antiquity, led to the discovery and introduction of the practice of insurance, in which, by combination and union, individual losses are made less by being divided among many.

Among the nations of antiquity, insurance of any kind was entirely unknown, though the practice of paying interest on loans was in vogue at the earliest historic period, as it is now among numerous uncivilized nations, who have no conception of insurance.

While the nations of antiquity — the Egyptians, the Greeks, and the Romans — had made great progress in many of the arts, had organized governments, put in operation systems of taxation, and carried on large commercial transactions, yet they never entered upon the course of social and financial progress which characterizes the whole development of modern society. The idea of such associations as banks, insurance companies, or joint stock companies was entirely unknown to them.

With the growth of commerce in the middle ages, a system of marine insurance grew up in some of the chief mercantile cities. In 1588, Chief Justice Coke, in one of the reports of his decisions, speaks of insurance in England as quite a novelty; but there is no question that it was in use prior to that time among the merchants of the continental cities, though, like many mercantile customs, it had become quite general before being recognized by the law.

The first English statute which mentions it was issued in 1601, in the reign of Queen Elizabeth. This first application of the principle of insurance was limited to marine risks. The manifest advantages gained by it led soon to its application to fire risks, and eventually to various other interests, as the insurance of growing crops against hail, which is largely done in the wine-growing regions of France, where hail storms from the Pyrenees are common, to the insuring of cattle and valuable stock of all kinds, to the insuring of boilers from explosion, travellers from accidents, and also to life insurance, which has become one of the most extensive and important branches of the whole business of insurance.

The precise date at which the practice of life insurance began is not known with any definiteness. It has been stated that within about four hundred years after the commencement of the Christian era, tables were in existence for the calculation of annuities.

This was, however, even accepting the statement that such calculations were made, very far from being anything more than the first step towards life insurance.

The next step towards the practical realization of life insurance was the introduction of the system of annuities. The first recorded instance of an organized attempt to introduce the use of annuities was that made by Lorenzo Tonto, or Tonti, a Neapolitan, who lived during the middle portion of the seventeenth century. His plan was as follows: A certain number of persons contributed a certain sum to a general fund, each contributing a specified amount, and no distinction being made either on account of age or sex. At the end of each year, the *interest* of the general fund thus created was divided among those of the contributors who were living. This was done year by year, until the sole survivor received the whole of the interest.

The increased interest received from time to time by the survivors, as the successive deaths of the subscribers diminished the number of participants, made this system quite popular for a time, until the question was raised what then became of the principal. On investigation, it having been found that the founders of the scheme appropriated this to their own use, a modification in the system was proposed, by which the subscribers were divided into classes, according to age, and the principal was to be divided among a certain number of the survivors, or to pass into the possession of the last one of them.

An association of this kind was formed by Tonti in France, under the patronage of Cardinal Mazarin, in 1653, and was called "The Royal Tontine." The subscribers were divided into ten classes, each class contributing 102,500 francs, making a total fund of 1,025,000 francs. The subscription of each member was three hundred francs. The last survivor was to receive the interest upon the entire capital, which, after his death, was to revert to the state. It was this last provision which probably caused the want of success of this scheme.

Sydney Smith, with the acute perception of the average character of the men of his time which distinguished him, once said, speaking of the unequal distribution of the income connected with the offices of the English Church, that it was better as it was than to make a more equable division. Though many curates starve on "forty pounds a year," yet the possible chance of perhaps becoming a bishop, with an income of a half million of pounds, induced

more persons to take up with the church as a profession than a more even distribution, without any such possible prize. This was, perhaps, true; but the reverend wit did not have a sufficiently philosophic perception of the growth of social organization to see that its tendency is with increasing culture to substitute the certainty of provision for the excitement of speculation, and to introduce stability and regularity into all our commercial relations.

As we shall still clearer see in the course of this article, the system of insurance has been much prompter in recognizing this tendency of social progress, and much readier than the church to foster this growth of social morality, by its practice, as well as its precepts.

Though this "Royal Tontine" was not successful, yet Tonti, who was an enthusiast in the advocacy of his system, proposed unsuccessfully before his death two other schemes, which were substantially the same in principle, though somewhat modified in their details. The idea was, however, in the world, and has since been repeatedly used. In 1689, Louis XIV. raised one million four hundred thousand francs by a Tontine divided into fourteen classes, embracing children of five years to persons of seventy. The last survivor of this association, a widow, died at the age of ninety-six, in 1726, having enjoyed for a few years an income of seventy-three thousand five hundred francs from her original investment of three hundred francs.

In 1773 Tontines, as a financial measure, were prohibited in France. In England the last Tontine established was in 1789, and as late as 1859 was still paying interest to survivors. In the United States the system was introduced into various cities, but never became very generally practised.

The chief value of the Tontine system was, that it stimulated a methodical investigation of the question of the probabilities of life, and to the gathering of some reliable statistics upon this subject, and also, from its purely speculative character, suggested the necessity for a change which should introduce a certainty into this species of investment, and thus prepared the way for the realization of this important step in social advance by life insurance.

Blaise Pascal, the famous author of the *Provincial Letters*, whose interest in the scientific advance of his age is well known, suggested in this work, which was most extensively read, the importance of applying the conclusions reached by the doctrine of probabilities to the well-being of mankind, and John De Wit, the

distinguished statesman of Holland, made use of Pascal's suggestion for the calculation of the annuities upon which the States General were borrowing money at this time. In the second volume of the *Assurance Magazine*, published in London, Mr. Hendriks has reproduced a report issued by De Wit upon life annuities, which was the first treatise upon the subject, and may be considered the inauguration of the modern system of applying mathematical formulæ and processes to the calculation of politico-social questions of this kind.

In an annuity, the payment of a certain capital secures the reception of a yearly income during the remainder of the annuitant's life. From this to the theory of life insurance, in which the payment of a small yearly sum secures at the payee's death, or at some future definite time, the reception by his heirs, or by himself, of a certain capital, would seem but so simple a step that it could be made almost immediately. But those who, from a study of the slow growth of social organization, know how difficult and tardy the process is, will not be surprised to find that this change was by no means immediate.

In all these previous attempts to realize the principle of insurance, the question of the risk must, of course, have been decided speculatively, rather than with mathematical accuracy. It required that care should be taken in registering the data, and that time enough should elapse to allow the working of the natural and accidental causes of mortality, before the materials could be gathered upon which any calculation could be based.

The counting of the population, or the taking of the census, had been a custom among nations from the earliest historic times, and the enumeration of the population, and of the ownership of the land, was made with great exactness in England in the Domesday books, which were completed in 1086. But these afforded no data by which to arrive at any accurate conception of the percentage of mortality.

The first parish registers were begun in England in 1538. They had been kept in Augsburg and Breslau for a long time before, but did not become general in Europe until the beginning of the next century. At first these registers were not kept with desirable accuracy as to the age of persons and the causes of their deaths which occurred, but in time these deficiencies were supplied, though it was not until 1728 that the ages were uniformly recorded.

In 1726, John Smart published *Tables of Interest, Discount, An-*

nuities, etc., in which he suggested that the parish clerks should make a return of the age of every person who died. This recommendation was carried into effect two years afterwards, as above mentioned. Towards the close of the sixteenth century, to quiet the apprehensions which existed throughout the country by the ravages of the plague, the English government commenced the weekly publication of "The Bills of Mortality," and from 1603 to the present time they have been issued regularly. Their publication excited attention to the subject of life and mortality, and early in the seventeenth century John Graunt published a work entitled *Natural and Political Observations on the Bills of Mortality*, which has been considered as the first step made in the collection of the mathematical data upon which the theory of life insurance is founded.

His contemporary, Sir William Petty, in his numerous publications, aided also in calling attention to subjects of political and social arithmetic, and in 1693, Dr. Halley, the astronomer royal, published the *Breslau Table of Mortality*. This was a table of the probabilities of life made up from the register of the deaths kept at Breslau, in Silesia. This table was published in the *Philosophical Transactions* for 1693, and being thus in a measure learnedly buried, did not excite the attention of the commercial circles which it might have done had it been made more accessible.

Mr. Hendriks, a writer on life insurance of well-deserved reputation, speaks of these tables thus: "Dr. Halley was the discoverer and scientific arranger of what are termed *life tables* in the full and highly important modern acceptation of the term, and in his paper (an estimate of the degrees of the mortality of mankind, etc.) he taught the world the best initiatory and theoretical form for the computation of life annuities and of survivorships, from and to given ages."

From this time the literature of life insurance increased steadily, and suggests that the practical application of the theories enunciated was more general than it really was. But the religious and superstitious objections to what was supposed to be a system of speculation upon death, stood so strongly in its way that it made but very slow advance. In 1681 an ordinance was issued in France forbidding it; and in other parts of the continent the same legislation created a prejudice against it, which has prevented its acceptance until quite within this century.

In England, the data for mathematical accuracy in life insurance

were slowly gathered; and though the practice of insurance suffered, as all new social methods suffer, from a period of inflation, when injudicious speculators seek to turn the growing interest of the public to the furtherance of their own selfish aims, yet the principles of stability and accuracy were vindicated by the general management of the companies, and new tables were constructed from more extended experience, until, in 1816, Mr. Joshua Milne produced the Carlisle Tables, based upon the observations of Dr. Heysham upon the mortality of Carlisle, which introduced the modern era of life insurance.

In the United States the practice of life insurance was introduced before the revolution by the formation of a society by some Episcopal ministers, in 1769. Their association was called the Protestant Episcopal Association for the Benefit of Widows and Children of Clergymen of the Commonwealth of Pennsylvania. The first public company was the Pennsylvania Company, which was established in 1812, and still continues in the business.

From that time the business increased slowly, until, about 1840, it received a new impetus, and has since progressed with new vigor, until there are now in the United States over one hundred life insurance companies, receiving annually an income from premiums of over one hundred millions of dollars a year, and creating policies yearly upon about half a million of lives, representing risks amounting to the enormous aggregate of over one thousand millions of dollars.

While there is no country in the world in which the practice of life insurance is so general, since social and business life in the United States is naturally stimulated into greater activity by the larger freedom of our political relations, there is also no country in which the principles of accuracy and stability have been more generally introduced into the business, and its organization infused with the democratic spirit of our institutions, by which the general welfare and benefit of the people, rather than that of a small class, is made the object and aim to be attained.

With the introduction of the mutual plan, life insurance ceases to be a speculation, but becomes an association of the policy holders, who, united together for a common object, and taking advantage of the strength there is in union, make the business the best investment possible for their premiums. With the proper organization of the company, and by intrusting its financial affairs to the direction of reliable and safe officers, the business becomes as

legitimate and safe as any — since speculation is entirely removed from it, and its operations reduced to the basis of mathematical certainty.

Among the numerous companies of the United States which have deservedly secured public confidence, the Phœnix Mutual Life Insurance Company, of Hartford, Conn., has been selected for mention here as the representative company for its reliability and its successful career. With its assets amounting to seven millions of dollars, its management still recognizes the importance of prudence and economy in the performance of their duties, and avoiding injudicious expenditure, have recently renewed the lease of their modest but suitable offices for another term of ten years.

The practical result of this theory of management appears in the able report of Mr. Barnes, the Insurance Commissioner of the State of New York, for the year 1869. Speaking of the Phœnix, he says that, in comparison with twenty of the leading companies, it stands lowest in "the ratio of loss to total income," and occupies the same position in "the ratio of disbursements to total income." By this course of management the stability of the Phœnix is assured and placed beyond all question. The official statements show that the company has nearly one hundred and forty-five dollars of assets invested for every hundred dollars of liability.

Aside from this claim upon public confidence, the Phœnix has, by the liberality of its policies, further attracted public attention. Organized in 1851, it has shown a steady increase in its yearly business. In 1863 it issued nine hundred and eighteen policies. This number has risen by progressive yearly steps, until, in 1869, it reached eight thousand six hundred and twenty-three. With an income of one hundred and eighteen thousand eight hundred and twenty dollars in 1863, its income in 1869 reached the total of two millions four hundred and thirty-two thousand nine hundred and seventy-nine dollars, a result which will compare most favorably with that of any other company, while it must be remembered that the judicious investment of the assets of the company make for the stability and certainty with which this duty is performed, even a more favorable statement than this.

THE TARIFF, A PROTECTION TO MANUFACTURES.

By HORACE GREELEY.

THE TARIFF A MODERN DEVICE. — ITS ADVANTAGES OVER OLD FORMS OF TAXATION. — OF THEORISTS WHO CONDEMN TARIFFS ALTOGETHER. — A LITTLE SCRIPTURE. — GENERAL WASHINGTON ON HOME PRODUCTIONS. — A TRUTH WHICH THE SOUTHERN CONFEDERATES REALIZED. — A POPULAR BUT FALLACIOUS SUGGESTION CONSIDERED. — WHY OUR MANUFACTURES HAVE PECULIAR NEED OF PROTECTION. — CHEAP LABOR IN OLD COUNTRIES. — WHAT OUR MANUFACTURES REQUIRE FOR THEIR PROTECTION. — THE ADVANTAGES OF BRITISH MANUFACTURERS. — IN WHAT MANUFACTURES WE LEAD THE WORLD. — OUR MANUFACTURES SUPPLIED TO THE PURCHASER CHEAPER UNDER PROTECTION THAN POSSIBLE UNDER FREE TRADE.

Tariff (from *Tarifa*, a small seaport on the Spanish coast of the Strait of Gibraltar, where this form of impost seems to have originated), is the generic designation of all taxes levied upon or restrictions affecting the introduction of the products of one country into the ports or other territory of another. It is a comparatively modern device, but was very rapidly and generally adopted by civilized nations, who swiftly discovered its superior efficiency and relative popularity to direct taxation. Its advantages are these: —

1. Fewer persons are required to levy, assess, and collect a given amount by tariff than by direct taxation.

2. It is less inquisitorial, and subjects comparatively few to the visitation and scrutiny of officials.

3. It insures juster and more equal taxation. In semi-barbarous countries like Turkey and Persia, the great majority hide or conceal their wealth, so far as possible, in order to evade the imperious exactions of the tax-gatherer. This renders his duties more invidious and his vocation more odious than it need or should be.

4. Under a tariff, most consumers pay taxes only when they see fit; that is to say, they escape taxation when they confine their purchases to home-made products.

There are theorists who condemn tariffs altogether, asserting a preference for that venerable system in vogue when (according to Scripture) "Cæsar Augustus" decreed that "all the [Roman] world

should be taxed." No civilized people, however, practically accepts this view; while our own country, throughout the eighty-odd years which have transpired since the States adopted her federal constitution, has never been without a tariff since her first federal congress had time to make one. Direct taxes have from time to time been imposed, always under the pressure of great financial necessities, and always to supplement, not supersede, her tariff. No party, no clique, as represented in Congress, has proposed the abrogation of all duties on imports, and a reliance on direct taxation for the maintenance of the federal government and the satisfaction of its liabilities. On the other hand, direct taxes levied in its behalf have always been exceptionally odious, and repealed, so soon as it was deemed practicable, to raise the sum required by tariff alone.

Nor has any Congress ever enacted an *undiscriminating* tariff, — that is, one which taxed equally each and every article imported. Protection (so called) and free trade have by turns prevailed; but, so far from enacting a uniform impost, the anti-protective tariff framed under the guidance of Robert J. Walker, in 1846, admitted certain articles free, and taxed others from twenty to one hundred per cent. By no vote within my recollection has any considerable party or section in Congress ever committed itself to the taxation of all imports alike.

But, while all favor discrimination, they differ widely as to the objects which discrimination should contemplate. General Washington, in one of his messages as President, urged that the home production of staples of prime necessity in time of war should be sought; and he instanced iron and gunpowder as articles for which we ought not to be dependent on foreign nations, whence our supplies would naturally fail or become precarious whenever we should be involved in hostilities with any great naval power. President Madison, in one of his messages, thoughtfully suggests that, though we might procure certain articles more cheaply from abroad so long as peace facilitated their importation, yet, whenever war should intervene, we might be subjected, by such dependence, to exactions which would speedily outweigh our entire previous saving by importation instead of home production, — a truth of which the Southern confederates realized the full force in our late civil war. Had they paid millions to build up manufactures and mining within their borders during the preceding decade, they would have saved them many times over in the reduced cost and more ample supply of their products during that arduous struggle.

A popular but fallacious suggestion would have duties levied mainly on luxuries, leaving necessaries free. Luxuries are usually of exceptional cost in proportion to their bulk, so as to be smuggled over a border with especial facility. Laces, gems, etc. are luxuries; but to levy high duties on these is to incite the cupidity of smugglers and often tempt to their clandestine introduction concealed in false-bottomed trunks, ladies' dresses, etc., etc. Like the singing crow in the fable, in reaching after too much, those who would tax luxuries exceptionally invoke the risk of getting nothing.

The most vehement condemners of protection all but uniformly vote in Congress to repeal all duties levied on coal, salt, wool, pig-iron, etc. Of course this involves the raising of larger sums from articles left subject to tariff taxation; since, if A. imports salt or coal free, B., who imports tea or sugar, or C., who imports something else, must pay more into the treasury than would otherwise be required of him.

"But why would you impose higher duties on manufactures than on other articles imported?"

General Jackson's answer * in substance was, — in order to create near and sure markets for the products of agriculture. "Withdraw (says he) six hundred thousand of our people from agriculture to employ them in manufactures, and you give to our farmers a larger and better market than all Europe now affords them." This view was substantially that of Henry Clay, A. J. Dallas, Hezekiah Niles, Walter Forward, R. C. Mallary, and the great body of those who guided the public mind out of the anarchy which seemed to prevail after the peace of 1815 to the assured and decisive triumph of protection in the enactment of the tariffs of 1824 and 1828. By the votes of States and communities preponderantly and often exclusively grain-growing, in contradistinction to those either cotton-planting or commercial, were these tariffs demanded and sustained. Had it been known in 1832 that General Jackson was about to desert, at the dictation of the slaveholding interest, the protectionists with whom he had hitherto affiliated, and to whom he still protested his identity of conviction and purpose with theirs, his re-election by the overwhelming vote of Pennsylvania and other States devoted to protection would have at least been doubtful. But, like too many a successful wooer, he gave his vows to one love and his hand to another.

* Letter to Dr. Coleman, 1824.

Manufactures in this country stand in exceptional need of protection because: —

I. They embody large values in small bulk, and are thus cheaply transferred from one country or hemisphere to another. A ton of Indian corn shipped from Iowa to England pays twice as much to the transporters as to the producer, while a ton of broadcloth or of silks may be sent from Europe to Iowa for less than five per cent of its value. In other words: — the producer of corn in Iowa must sell it there for a third of its cost to the consumer in England, who can nevertheless obtain at his mill seven-eighths of the price at which (but for our tariff) his cloth could be delivered in Iowa. Hence, nations that export grain and buy their fabrics of distant communities are always poor and in debt. They are forced, by the inexorable laws of trade, to sell their surplus products for less than half their average value throughout the world.

II. Cheap labor in old and densely peopled countries, as compared with its cost in new and thinly settled regions, is inevitable; and this gives the former a great advantage in the production and sale of manufactures. The latter, having an abundance of cheap and fertile land, may produce bread and meat cheaper, but not wares and fabrics. And, other things being equal, the cheaper skilled labor will underwork and supplant those manufacturing industries which employ the dearer. The heavier weight in equal scales causes the lighter to kick the beam.

III. Manufacturers, in our day, require large aggregations of capital, machinery, experience, and skill. Nearly all of them are cheapened by inventions still under patent, constantly re-enforced and superseded by newer as the old become common property. No one can profitably make pins (for instance) by the aid of thirty-nine inventions which have, by the lapse of time, ceased to belong to the inventor or his assigns, while some one else owns and uses a fortieth invention no better than any of the thirty-nine, but still rendering the product cheaper or more perfect than it otherwise could be made. And, beside, a house which, for two or three generations, has supplied purchasers with a good article, has an immense advantage over one which still has its reputation to achieve. I confidently believe (for instance) that as good steel is now made in this country as in Europe; but I know that it cannot be sold so readily nor for so high a price as the best European steel. Whoever makes files, or ploughs, or axes, or cutlery, naturally says, "I *hope* the American steel will prove of prime quality; but I *know* the best British steel will

not fail me, and I dare not take the hazard of a failure which would ruin my business." So the American producers of steel must sell cheaper than their British rivals or not sell at all.

IV. British manufacturers have an immense advantage over ours in the extent and multiplicity of their markets. It may be fairly said that all the world faces London and Manchester, as it does not face Lowell and Philadelphia. If a merchant in Madagascar or Borneo, Brazil or New Zealand, wants cloth, or steel, or cutlery, he looks to Europe for it as a matter of course; he never dreams that it may be obtained from the United States. Though it were made better and cheaper here, he would continue to order from Europe; the invisible threads of commerce run from his store to her workshops; he follows a well-beaten track rather than seek out a new and untried one. Steamships bring him the products of European mills, forges, and shops; we cannot compete with those argosies because we have not an assured demand for our finer products; and we cannot create the demand because we lack the lines of steamships through which to supply it.

V. It is easy to sneer at "*infant* manufactures," and wonder when they will shed their milk-teeth. The ignorant and stupid will never consider that the great manufacturing establishments of Europe are the slow and steady growth, not of generations, but of centuries,— that the broadcloth which you buy for your coat is the result of ten thousand distinct, successive inventions and discoveries auxiliary to the comber's, the dyer's, the spinner's, the weaver's handicrafts. The babyhood of an elephant outlasts the average life of a dog. Rare excellence ripens slowly. Our oldest manufactures are antedated by our oldest living citizens; yet we lead the world in making edge tools, cut nails, mowers and reapers, ploughs, sewing-machines, and many substantial fabrics. Europe may make some of these cheaper than we do, but of inferior quality to ours. We have lately learned to make mill-saws, and no country ever made better than ours. Having taught Europe to cut nails, we are about to teach her to supersede these by machine-made *wrought* nails, nearly as cheap as cut, and of infinitely superior quality. The best bed blankets ever made on earth are woven from American wool in California; but Minnesota treads close on her heels, with Colorado not far behind. A factory in Waukesha, Wisconsin, makes woollen shawls exclusively, such as cost at retail $8 to $12 and are worn by a majority of our countrywomen; a mercantile firm in Chicago takes every shawl so soon as made, and calls for more. Not less than five

hundred woollen-factories are now running in our Western States, while the gigantic furnace-fires irradiating the midnights of Cleveland, St. Louis, Chicago, Detroit, and Milwaukee, are steadily converting the ores of Lake Superior, and Illinois, and Wisconsin into pig-iron, and thence into bars and steel rails. If our theorists will but let us alone, we shall go on extending and perfecting our production of metals, wares, and fabrics, until it will be beyond the reach of competition.

"Then you admit that we pay more for home-made than we would or need pay for foreign manufactures?"

No, I do not. On the contrary, I firmly believe that we obtain them far cheaper, in the average, of our own producers under protection, than we could of their foreign rivals under free trade. The *money* price of the latter might be less; but their cost in our *products* would be vastly more. The fruits, vegetables, hay, timber, fuel, etc., which our farmers now advantageously exchange for the wares and fabrics they buy, would not sell for half so much — would often find no purchaser at all — if we imported our manufactures from European workshops. Values are not positive, but relative; and the farmer who now buys annually $ 100 worth of fabrics, and pays for them by the sale of choice apples at $ 1 per bushel, would not be a gainer by buying instead his fabrics (imported) for $ 75 and selling his apples at 25 cents per bushel, because of a falling off of customers. And this, to my mind, fairly illustrates the average farmer's loss and gain by protection as contrasted with free trade.

But enough. I have sought only to indicate positions, not to exhaust discussion. My views on this subject have been set forth more fully, and those who care to consider them may readily find them. It suffices here that I have shown that protection is no device of manufacturers to aggrandize their calling and increase their gains, but a thoughtful and comprehensive endeavor, by the patriots and statesmen of three generations, to diversify the industry, enlarge the earnings, and increase the prosperity of the whole American people.

PHOTOGRAPHY.

THE CHANCES OF INVENTORS. — THE FIRST SUGGESTION OF PHOTOGRAPHY. — WEDGWOOD AND DAVY. — NIEPCE AND DAGUERRE. — THE DAGUERREOTYPE. — THE PHOTOGRAPH. — THE PROCESS OF TAKING SUN PICTURES. — TALBOT. — HIS IMPROVEMENTS. — THE PROCESS OF TAKING PHOTOGRAPHS. — THE EXTENT OF THE BUSINESS. — FERROTYPES. — THE FUTURE OF PHOTOGRAPHY.

Some inventions are happy accidents, others are developed by slow and painstaking diligence. In reviewing the history of great discoveries we sometimes wonder by what brilliant chance a great idea occurred to the mind of an obscure searcher after some better way; and sometimes we see a series of patient investigators, all fascinated with the importance of the end to be attained, one proposing to master a difficulty in one way, another by a different method, each working for years, and contributing his own well-cut square of hammered stone to the shaft that stands at last complete and beautiful. In the latter way has the marvellous art of drawing by the chemical power of sunbeams emerged from dimness and shadows, every year since 1840, growing clearer and better defined, avoiding errors, overcoming faults, mastering objections, throwing older methods into the background, till at last it has come as near to perfection as the advancement of chemical science and the keenness of human faculties will allow.

Almost a century ago chemists had observed that nitrate of silver is a substance that is curiously affected by the sun's rays, and it had occurred to them that somehow this property might be used in the pictorial art. Near the beginning of this century two of the ablest chemists of England, Josiah Wedgwood and Humphry Davy, succeeded in producing sun pictures by smearing a leather surface with a solution of nitrate of silver, and laying over it a picture on glass. The shades of the glass picture would protect the silvered surface, and the lights on it would expose that surface in such a way that the glass picture would be copied on the

leather, but with inversion as to light and shade. At this point photography remained for almost forty years, no substance or treatment having been hit upon that could dissolve the unaltered salt of silver and fix the picture.

Between 1830 and 1840 two French chemists devoted most of their time to the mastery of the difficulties which begirt the problem. These men were Niepce and Daguerre. Niepce found out a way to coat a metal plate with a thin film of bitumen, and expose it for several hours to the sun's rays. The actinism of the rays would act unequally on the bitumen, according to the lines on the glass above; and after removing the negative, as we now call it, he found that certain essential oils, as that of lavender, would develop the positive by rendering the thin film of bitumen insoluble.

Daguerre aimed at the same results as his brother chemist, and sought them by means which have since proved more effective. He prepared his plate by exposing a polished silver surface to the vapor of iodine. In this way he obtained a sensitiveness which enabled him to use the camera, and to obtain results by a few seconds' exposure. The picture was developed with the vapor of mercury, and fixed by the hyposulphite of soda. It was right that the name of Daguerre should be inseparably connected, as it has been, with this art. He discovered the art of developing latent photographs with vapor of mercury, and he hit upon a rare and little known combination of soda and sulphur as the best chemical for fixing the impressions. The plates which he used were silver or copper, well plated. The highly-polished silver surface was subjected to vapor of iodine in a dark chamber, then in a camera exposed to the rays which come from the object to be pictured. His mode of developing the dim shadow thus obtained has been greatly improved, but his mode of fixation, or rendering permanent, has not been greatly changed by forty years of enthusiastic research.

Now and then we may find one of those weird, shadowy pictures, made in 1840 and 1841, when the discovery of Daguerre was first presented to an admiring public. In clearness, force, and brilliancy they are far beneath the splendid pictures which come from the galleries of Gurney, of Brady, of Salomon, of Kurtz; but when held at the proper angle, and in a strong light, the likeness they present is admirable, and when the materials were well handled there are as yet no traces of "decay's effacing fingers."

The daguerreotype was very properly named from the skilful and persevering French chemist, who, ranging through hundreds of substances in his trials, at last hit upon vapor of mercury for developing, and a combination of soda and sulphur for fixing, sun-drawings. But the photograph, as we now have it, was mainly an English invention. Six months before Daguerre published his art, Fox Talbot, an English chemist, in a paper laid before the Royal Society, described a sensitive paper for copying drawings or paintings by direct contact. The paper was bathed in a solution of chloride of sodium, and then in a solution of nitrate of silver. Thus he obtained on paper a film of chloride of silver, and the copying was effected by placing the object, which must be in parts transparent, upon the sensitive paper, and exposing it to the rays of the sun. In this way Talbot, as early as 1840, had made a *negative*, that is, a picture in which the lights and shades were inverted, and from this negative he produced positives by fixing the first impression and placing it on another piece of sensitive paper. This negative could be multiplied and the copies used to make other positives, and thus photographic printing was seen to be practicable.

The next year, 1841, Talbot's constant experiments were successful in giving photography another grand advance. He prepared paper with iodide of silver, thus making it sensitive to light, fixed it in the camera, threw an image upon it with a lens, and then developed the shadow into a picture, and fixed it with the chemical that Daguerre used — the hyposulphite of soda. Thus Talbot made paper negatives, with which quite good positives could be printed ; but there was an essential difficulty with them — a want of unity of structure and delicacy of lines inseparable from the use of even the best paper. Hence, from 1840 to 1850, most sun pictures were made upon silver plate, and were very properly called daguerreotypes.

About the year 1851 the art of making glass negatives was invented. At first albumen was used as a film or coating on plate glass, and albumen plates are still used by some artists. Legray was the first to suggest that collodion would make a better film for photographic manipulation than albumen. This substance is produced by dissolving gun cotton in ether and alcohol, the alcohol being a little in excess. When the solution is poured on a plate of clean glass, it forms a very thin, even, and transparent film, which quickly dries, and can scarcely be distinguished from

the surface of the glass beneath. The plate must be held at an angle and looked at closely before one can be sure that it has been coated. This delicate collodion surface can be made sensitive to light just like a silver plate; an image can be thrown upon it, it may be developed by combination of iron with sulphur and with nitrate, and it may be fixed with a combination of potash.

There are two ways of finishing this collodion shadow into a picture. It may be deepened or intensified, fixed and set against a dark background, when it becomes a glass positive, sometimes called a melanotype on account of its prevailing dark or shadowy tints. But the method which is far more common proposes to work this collodion shadow into a glass negative or type, from which any number of pictures may be taken by allowing the light to shine through it upon properly sensitized paper.

The perfection and development of this collodion process have given modern civilization a new and wonderful art. By it a portrait can, in a few seconds, be thrown upon a film on a bit of plate glass. After that the sitter may go his way; he may travel to the ends of the earth, he may fall in battle; his true and very likeness, more like him than the most gifted artist in the world could paint him, can be fixed upon the glass; the glass may be used as a type by which sunlight will stamp ten thousand images upon paper, and at a cost of from two to five cents the picture, can be transferred to the pockets or the albums of millions.

Within twenty years, since collodion came to be a prominent chemical in photography, there have, of course, been a thousand delicate and strictly chemical improvements in every step of the process. The quality of the coating material has been carefully studied, and artists have discovered just the right combinations of gun cotton, alcohol, and ether to use. The best mode of making this film sensitive, the best material for developing the shadows when thrown upon it, the manipulation best adapted to remove defects in the impression, the bath that will set the lines, and more than all, the most approved and skilful handling of the glass as a type to print with, and the various modes of toning, softening, intensifying, and fixing the pictures thrown from the glass to the paper, have been studied with persistent enthusiasm. Each noted gallery has its little secrets of the dark room. Some artists excel in the treatment of their sitters in securing an easy pose, in getting a natural expression, in throwing just the right light, enough and not too much, upon this or that feature or limb.

Others, again, surpass in the chemical branch of the art; they know just how to manage the silver bath, just how many grains of protosulphate of iron to use, and exactly how the hyposulphite of soda is to be applied as a fixing solution.

It is not usual to find the grace and judgment of the artist combined with the nice knowledge and careful manipulation of the chemist. Most galleries have, therefore, one or more who devote themselves wholly to the study of light and shade, posture, expression, and the mysteries of actinism, while the arts, and niceties, and strange names of the dark room are given over to a chemist. In large cities the business of photography is dividing at this point into separate establishments. In one gallery nothing is done but to make the best possible negatives. The glass plates are taken to a photographic printer, who knows little or nothing of the camera, but gains by long practice and exquisite judgment in the matter of actinism, of the lightness and the depths of different negatives, and the various and strange chemicals that are to compose the solutions in which the paper takes its successive baths.

To give all the minute arts and expedients by which a first-class picture is produced would be to prepare a manual for the photographic operator; but the general reader may be interested in a description of the chief steps in the interesting and complicated process. To produce a negative, the essential things are a camera, a dark closet, a bottle of collodion, a plate of clear glass, a solution of nitrate of silver, a bottle of developing solution, made mostly of sulphate of iron with a little nitric acid, a bottle of fixing solution, made by dissolving five ounces of hyposulphite of soda in five ounces of water. Shallow dishes, like a soup plate, will be needed, and a plenty of clear water. The person or article to be photographed is placed directly before the camera, and this is moved back and forth till the inverted image rests in the camera just as the artist would have it look on his glass. He goes now into his closet, and wiping his glass clean, pours about a spoonful of collodion on it, and tips it in different directions till the delicate gum has flowed over the whole surface. Before the collodion dries, the plate is plunged gently into a bath of nitrate of silver, where it is moved backward and forward till the surface has a clear, creamy film all over it. It is drained for a moment, and placed in the dark frame, which is at once set into the camera, and the tube and the sitter adjusted as before. Now the

cap of the camera is removed, and the image is thrown upon the plate in a space of time that constantly varies. Perhaps thirty seconds is about the average time of the exposure of a properly prepared plate. The plate is at once removed to the closet. The artist takes it by one corner, collodion side up, and pours about an ounce of the developing fluid upon the surface, and flows it back and forth, looking down upon it and through it, to watch the coming out of the picture. If it comes out quick, the light places very light and the dark quite heavy, he has burnt his plate — the exposure was too long. If it comes out very slowly, and the outline is dim and vague, his error was the other way — he did not expose his plate long enough. The happy medium between these two is the right time of exposure.

When this has been hit upon, the image makes its appearance steadily and gradually, first the high lights, as the pearly brow or the snowy linen, next the light shades, and finally the shadows. When all the details come out well, pour the developer off, wash the plate, and examine it in clear light. As it is a negative, the whites will be dark in the glass, and the parts that will print dark show nearly transparent. If the whole picture is full of gradations and half tones, with no parts quite opaque, and the dark parts clear, the artist has a good negative, and he may pour the hyposulphite of soda over it to set everything just as it is. In some cases a solution made up mostly of pyrogallic, with a little citric acid, is poured over the negative before it is set. This has the effect of intensifying the picture, making the whites whiter and the darks darker; but the acid is an application to be made with much caution, as good judgment and a happy hit in the time of sitting will render the acid process unnecessary. The soda used for fixing must be carefully washed away, and the negative is done.

The next stage in the process is printing from this negative. For this purpose sensitized paper is used, prepared as follows: A sheet of clear, strong linen paper is dipped in a solution of iodide of potassium, mixed with a little sugar of milk. When it has been washed and dried, it is dipped in a solution of nitrate of silver, to which a little acetic acid has been added. This gives a film of iodide of silver, and if exposed to the light it would turn dark. It is, therefore, made sensitive in a dark chamber, and kept in close boxes till ready for use. The negative is carefully laid over a sheet of this sensitized paper, and the frame that clasps

both is laid in the sun. Much judgment is required in knowing just how long a negative should be exposed. Much depends on the character of the negative, and still more on the actinic quality of the rays, for this is an element which varies every day, and each hour in the day. When the paper has been under the negative long enough, throw it into a vessel of water, and move it considerably. When the nitrate has been washed away in pure water and a weak brine, the paper goes into the toning bath. This is a solution of chloride of gold, with a little alcohol and a little soda added. Then it passes into the fixing solution, which is the same as was used for fixing the negative. When dry, the picture is done. It only remains to paste it on some firm background, trim, and set in its frame, or attach to the card-board. A few subtleties and refinements have been omitted in this account, but in substantially the way described nineteen twentieths of the photographic business of this country is conducted.

As an industry, photography has grown to proportions that surprise. The best indication of the immense extent to which pictures are taken is found in the quantity of prepared or albumenized paper required. There are but two mills in the world where this is made, one in Germany and the other in France, the finest and purest of linen being used, and every part of the process is carefully watched, as the least metallic substance in the pulp would render the paper wholly unfit for photographers. There are four hundred and eighty sheets in a ream, and each sheet, as consumed by the artists, makes probably thirty pictures; that is, fourteen thousand four hundred photographs are made from a ream. We import thirty-five hundred of these reams annually. This indicates the amazing number of fifty millions and four hundred thousand photographs made every year.

Besides photographs there are ferrotypes, made by throwing a picture on a surface of tin. This is the cheapest form of picture, and great numbers of them are taken, nearly every large town having one or more cheap galleries, where "six pictures for a quarter of a dollar" draw the million.

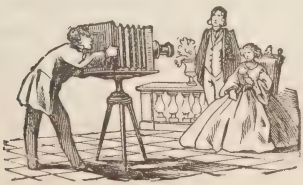
There are about five thousand two hundred and fifty persons in the United States who follow photography as a business, and the leading house in this country in photographic materials estimates that each gallery or operator consumes two hundred dollars' worth of chemicals and paper annually. To obtain a cheap outfit for making cards of the usual size, one requires an outlay of some

two hundred or two hundred and fifty dollars. The great galleries of the metropolis, where sometimes eighty or a hundred first-class pictures are made in a day, have expended at least three thousand dollars in their chemical and mechanical outfit, and, including the dark room, the drapery, and the various devices for regulating the light, the outlay for equipping a first-class gallery is not less than ten thousand dollars.

The extent to which sun-drawing has been applied as a substitute for printing, and for hand-drawing for wood-cutters, though interesting and full of hope for the future, will hardly entitle these experiments to a rank among the great industries.

In both branches of this marvellous art, the artistic and the chemical, there is encouragement for the most zealous and hopeful laborer. Wonderful advances have been made in the skill with which lights are managed, with which the actinic power of light has been mastered and made subservient to art. Several enthusiasts on both sides of the ocean are making nice experiments in the hope of solving that most difficult problem in the art, that of reproducing tints as well as forms, securing a photography of natural colors, as well as an accurate transcript of figure and expression. By using bromide, as well as iodide of silver, great delicacy and sensitiveness of surface are obtained, so that we may expect to see, not merely the fixed and standard expression, but the flitting and evanescent shades of character, reproduced. In this way this curious art promises to give us individual history in a series of sketches, following the person with the accuracy of nature, and furnishing us, not one picture of a friend, but a hundred tracing him

"From grave to gay, from lively to severe."



A NEW METHOD OF TRANSPORTATION.

METHODS OF TRANSPORTATION HERETOFORE USED. — THE NEW PRINCIPLE AND ITS METHOD. — THE NEW ROAD BED OR TRACK. — MODE OF OPERATING THE NEW METHOD. — MANNER OF STOPPING THE SPHERES. — RATE OF SPEED. — COST OF CONSTRUCTION. — ECONOMY OF MANAGEMENT.

Although this new method of transportation is not as yet practically in operation, and cannot, therefore, be strictly classed as a great industry, yet it has been thought advisable to introduce a notice of it in this work. As yet it is only in the theoretical stage of development; but the advantages it offers are so manifest that we feel confident our readers will be pleased to know the means which it proposes for a cheaper and swifter circulation of the products of industry than is at present in use, and we feel that its introduction here is strictly in conformity with the design which has presided over the preparation of this volume. The notice we give of it is prepared from the statement of its method, written by its inventor, Mr. Albert Brisbane, of New York city.

General Views.

The great advantages of rapid and cheap transportation are so well understood at the present day that it is unnecessary to explain the importance of an invention which proposes to transport the mails and products of the country — its grains, fruits, meats, cotton, highwines, oils, minerals, coal, and merchandise generally — to and from all parts of it in a few hours, instead of days, and at a cost far less than by means of railroads. It will at once be admitted that such an invention, if practicable, will be of incalculable benefit, and will inaugurate a new era in the industrial and commercial interests of the world.

Methods heretofore used.

If we ascend to primitive historical times, and examine the methods of transportation which have been used, we shall find

that but two distinct methods have been employed. In the earlier times animals, tamed and brought under subjection, were used as carriers. The horse, ass, ox, camel, dromedary, and elephant were the animals domesticated and used for that purpose.

The first device, to effect transportation by mechanical means, was the wheel. At first rude carts with two wheels were constructed; and these simple vehicles were drawn, by the animals already tamed, on the natural surface of the earth, which was the primitive and simple road-bed to which man resorted. Next wagons with four wheels were devised, and artificial roads were made by levelling and grading. Then springs were invented — an improvement which was unknown to the Greeks and Romans. At length the railroad system was invented, substituting an iron track or road-bed, level and straight, in the place of the old road-bed of earth or hammered stone, and the locomotive in the place of the horse. The railroad is the full and complete development of the system that employs the wheel and axle principle; it unites all the conditions for rendering it the most efficient and practicable, and completes the series of improvements possible in this direction.

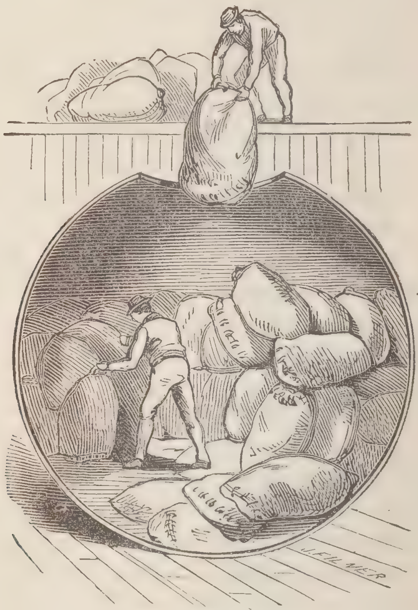
The New Principle and its Method.

The invention that has now been made introduces a new principle, and with it a new system, fundamentally different from the old. It starts from the full development and completion of the old, and introduces something entirely new in its place.

The new means or instrument of locomotion which the invention employs is the sphere, an instrument which it substitutes in place of the wheel. The sphere is the simplest and the true form of a vehicle of motion. It revolves upon its periphery without friction, is moved with the least power, and permits the highest rate of speed attainable by any form of ponderable or material body. Nature, in all her departments in which she requires high velocity, employs the sphere as the form best adapted to rapid and unvarying motion, as is exemplified in all her works, from the planet, which is a spherical body, rotating on an imaginary axis, to the falling drop of rain, which assumes the spherical form in passing rapidly through free space.

To adapt the sphere to the purpose of transportation, it is made hollow, and the load to be carried is placed inside. Thus hollow spheres or globes, carrying their loads inside, are the vehicles used under the new system. They may be of any size, from two feet

to ten in diameter. They would be made of metal, — thin cast-steel shells for the smaller sizes, and boiler iron for the larger sizes, — turned in a lathe with precision, so as to roll evenly and smoothly. They would be provided with apertures, or "man-holes" (with covers made to screw in, so as to form a part of the surface), through which they could be loaded and discharged easily and readily.



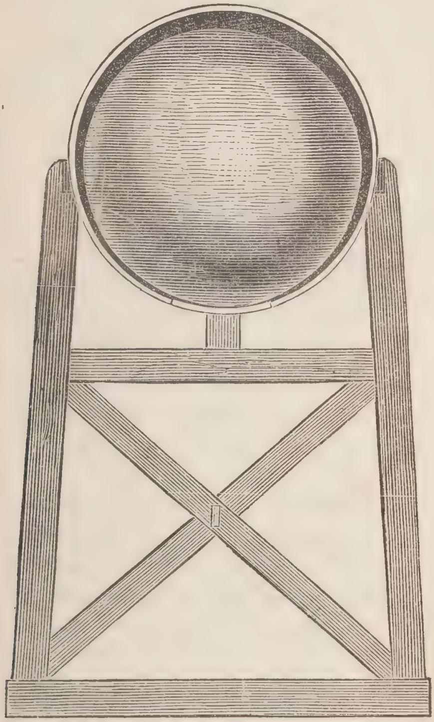
PACKING A SPHERE.

The New Road-bed or Track.

The properties of the pneumatic tube fit it perfectly for the new vehicle of motion. It will furnish the vehicle, first, a road-bed that is even, smooth, and solid; second, entirely free from dirt and dust, or other obstructions, and protected against the disturbing action of the wind, rain, and snow; and third, a passage-way in which the spheres, moving with the current of air, will not be impeded in their course by the resistance of the atmosphere. The tubes will be constructed a very little larger than the spheres, to allow them a free passage. A metallic rail or plate will be placed as a road-bed on the bottom of the tube, of a suitable width, and slightly concave, to adapt it to the convexity of the sphere.

From these explanations it will be seen that the invention consists in employing hollow spheres or globes, with the load to be transported inside, operating in pneumatic tubes.

Lines of pneumatic tubes can be cheaply and rapidly constructed throughout all parts of the country. Straight lines should, as far as practicable, be preserved; but ascents are of but little importance, as the spheres, when in rapid motion, will overcome



FRAMEWORK SUPPORTING THE TUBE, WITH SPHERE INSIDE.

steep grades. The tubes may be placed under or over ground, but better over, raised some fifteen feet in the air, and supported on posts or piers. Wood is the best material with which to construct the tubes; it would not expand and contract with the heat and cold, like iron, while it would be far cheaper. Narrow planks, tongued and grooved, properly seasoned and saturated with oil or coal-tar, would furnish the best kind of material. By a system of way-stations and relays of power at proper distances, the lines of

tubes can be made to connect the towns and cities of the entire country, effecting transportation rapidly and cheaply to and from all parts of it.

Mode of Operating the New Method.

Let us imagine a line, one hundred miles in length, constructed between two cities. When the spheres are to be forwarded, the mouth of the tube, at the end from which they are to be sent, is closed, and the air exhausted for a short time from the other end, and at way-stations, if necessary, by air-pumps worked by steam. As soon as a sufficient quantity is exhausted to cause a current to set in, the mouth at the closed end is opened, and the spheres are rolled in at short intervals, the exhausting process being kept up in the mean time. The current of air rushing in and striking the spheres will carry them rapidly forward to their destination. If they are set in motion by a slight fall in the tube, or a push, they will then move by the application of very little force. If necessary, a current of air can be driven in upon them.

Manner of Stopping the Spheres.

At each station a succession of brakes, held down by springs, will be placed on the top of the tube. There may be fifty of these brakes, if necessary, ranged one after the other in close proximity. They will be concave, so as to clasp the sphere, and present a large surface as it strikes them. They will be lined with leather or gutta percha to prevent any abrasion of the surfaces.

The strength of the springs and the pressure they will effect will be proportional to the size of the sphere, and the weight to be brought to bear. In addition to the brakes, the current of air can be reversed and thrown in, causing the spheres to meet an elastic air-cushion as they arrive at their destination. When the spheres are to be stopped, the brakes will be put down, and the spheres, striking them one after the other, will raise each in succession, with more and more difficulty, until they are brought to a stand. Lines of telegraphic wires will run through the tubes, furnishing at every moment information in relation to the position of the spheres, and transmitting orders for the regulation of their movements.

Care will be taken to pack the load in the spheres securely and tightly, or in the compartments, if necessary. Besides, centrifugal action and rotary motion will suffice to keep everything in its

place, even if not tightly packed, except at the moment of departure and of arrival. It is to prevent shaking at these two transitional points that the proper packing of articles liable to injury will be requisite. When the spheres are once in motion, nothing inside will move. The effect of rotary and centrifugal action is illustrated in the case of revolving cylinders, in which ores are rubbed and castings cleaned. They must revolve slowly to permit the articles within to fall. A cylinder four feet in diameter can make about thirty-six revolutions in a minute, which is equal to a speed of seven feet a second, or five miles an hour. Above this rate centrifugal action begins to counterbalance gravity.

Rate of Speed.

A locomotive, running alone and on a good track, will attain a speed of one hundred miles an hour. If this rate of speed is possible with a heavy vehicle, weighing thirty tons and running on sixteen wheels, and on two separate rails that are never laid exactly even and smooth, we may safely calculate for the spheres, moving on their smooth and even track, and on a rolling surface much less in breadth than that of a single wheel, a speed of at least double, or two hundred miles an hour.

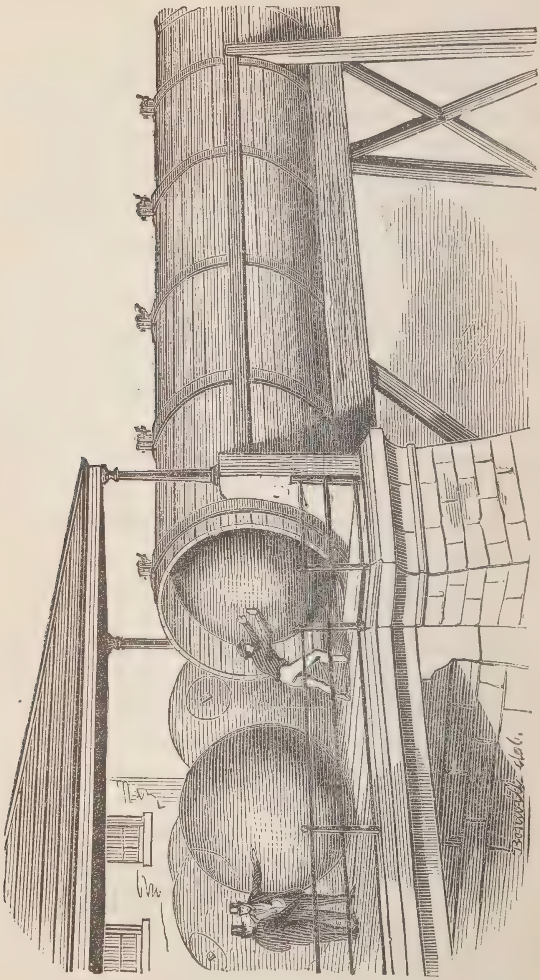
Cost of Construction.

An intelligent carpenter can, with proper data, calculate the cost per mile of the tubes. If proper mechanical facilities are provided to construct the tubes, they can be put together rapidly and cheaply. The spheres will not be expensive; one of five or six feet diameter, made of cast-steel half an inch thick, would cost less than a pair of cast-iron car-wheels, the axletrees and springs and the framework for holding them not included. The land ought to be a light expense, as it would be but slightly damaged by the posts. A line of tubes, six to eight feet diameter, could be constructed for a half or third of what a line of railroad costs, and that in the United States, where railroads are built cheaply. Let a single trial demonstrate the practicability of the method, and the question of expense will be of no importance.

Economy of Management.

Transportation will, under the new method, be extremely simple and economical. A train of one hundred spheres, once under way, will move on to their destination without a hand to touch them, or

an eye to look after them. What a contrast with the railroad! A train of cars requires for its management the constant attention



PLACING THE LOADED SPHERES IN THE TUBE.

of an engineer, a fireman, a conductor, and several brakemen, switchmen, and trackmen, while the wear and tear of track and rolling stock are enormous.

GLASS.

THE ART IN EARLY TIMES. — THE SKILL OF THE EGYPTIANS IN MAKING GLASS. — GLASS AMONG THE ROMANS. — THE CRUSADES AND GLASS MAKING. — VENETIAN GLASS WARE. — TECHNICAL DEFINITION OF GLASS. — THE VARIETIES OF GLASS. — THE QUALITIES OF GLASS. — ANOTHER CLASSIFICATION OF GLASS. — THE COMMENCEMENT OF GLASS MAKING IN THIS COUNTRY. — THE EXTENT OF THE BUSINESS. — ITS PROBABLE FUTURE.

THE art of making glass was known at a very early period in history; in fact, the discovery of this art dates so far back that all record of it is lost. With the mummies taken from the Egyptian tombs, beads and other ornaments of glass, colored to imitate precious stones, have been found. The date of their manufacture must be carried back more than three thousand years. In the tombs at Beni-Hassan, and in other places, pictorial representations have been found of the process of glass making, thus proving that the Egyptians were acquainted with this manufacture in the age of Osirtasen I., who reigned three thousand five hundred years ago, and was most probably a contemporary of Joseph.

From the Egyptians the Assyrians undoubtedly became acquainted with the process, and the Jews, during their captivity, must have learned the art. Yet, singularly, the only allusion to it in the old Testament is a passage in *Job* xxviii. 17, "the gold and the crystal cannot equal it," and that this was intended to refer to glass is strongly questioned by good authorities. The Egyptians were acquainted with many of the arts of working in glass. They could cut, grind, engrave, and even enamel it. In the ruins of Nineveh, lenses, vases, bottles, and various other utensils have been found. It is most probable, however, that the first suggestions of glass making were derived from the glazing which frequently takes place in baking pottery, and that by various experiments they happened upon several processes of its manufacture. We know that the ancients had not arrived at the

positive knowledge of modern times, and had not the ability, by chemical analysis, to accurately understand what caused their failures, or what was necessary to be done to insure success in the future.

From the Egyptians the Phœnicians unquestionably derived their knowledge of the art of glass making, though Pliny ascribes their discovery of it to accident. According to his account, some sailors who were shipwrecked built a fire on the beach, and found that the sand, from its contact with some lumps of soda, had fused into a glass. Such an explanation was satisfactory to the spirit of history in ancient times, when the accidental or the marvellous was more readily received as the cause of anything than the regular and orderly course of cause and effect. With the sceptical spirit of modern history, however, such accounts must submit to the test of logical examination, and, as in this instance, are rejected if they cannot stand it. We know that a fire so built, in the open air, and only for the purpose of cooking, could not fuse sand, never mind how much soda was accidentally present.

In the time of Pliny and Strabo, glass works, according to their statements, were in operation at Alexandria and at Sidon, while Theophrastus states that three hundred and seventy years before the commencement of our Christian era the arts of cutting, grinding, coloring, and gilding glass were in use, and that articles of exquisite workmanship were produced, but were so costly as to be possessed only as luxuries by the very rich. The Emperor Aurelian, it is said, required a portion of the tribute from Egypt to be paid in articles of glass.

The manufacture of glass was introduced into Rome during the time of Cicero, who died in the year 43 B. C. In the third century, articles of glass were in common use in Rome, and in Herculaneum various utensils made of it have been discovered, and in Pompeii window glass, though the Romans generally used sheets of mica for their windows, when they used anything, to make them a protection from the outer air, which the mildness of their climate rendered generally unnecessary. Stained glass is known to have been used in the churches of Europe as early as in the eighth century; but its use in private houses was much later, so that as late even as the twelfth century, a house in England in which the windows were provided with glass was considered to have everything which luxury could afford.

The crusades, which did so much to give Western Europe a

practical knowledge of the industries and civilization of the East, were the immediate cause of the introduction of the manufacture of glass into Venice, where the art was greatly improved, new processes being invented, until the industry became one of the chief sources of the wealth of the state. Venetian glass became famous all over Europe, and to-day articles of this manufacture are among the most choice and valuable treasures of the various art and industrial museums. During the middle ages, it was quite generally believed that a certain kind of Venetian glass had the rare virtue of shivering to fragments when any poison was introduced into a vessel made from it; nor has the tradition entirely died out to this day.

This industry, during its flourishing period, was guarded most jealously by the state; the workmen were granted certain privileges, but were carefully guarded to prevent their carrying the knowledge of the process into other countries, or to sell the information to strangers. It was at the Venetian factories that mirrors were first made of glass, and soon replaced the use of those of polished metal, which had been used by the ancients. The financial importance of this industry, as developed by the Venetians, was soon seen by the French, and the government offered great inducements for its introduction. As early as 1634 attempts were made to manufacture mirrors, and in 1666 workmen were obtained from Venice for the purpose of introducing the Venetian processes. In 1688 Abraham Thevart discovered the method of casting mirror plates, and soon after a factory for their production was established at St. Gobain, which for nearly a century retained the monopoly for the manufacture of this desirable article of luxury.

In England, it is claimed that window glass was made as early as 1439. Walpole, in his *Anecdotes of Painting*, has given an old builder's contract, from which this fact appears. But at this time it also appears that a preference was given to that which was imported. It is certain, however, that a manufacture of window glass was established in London in 1557, and that soon after a fine quality of flint glass was manufactured in another factory in the same place. Coal was introduced as fuel in the place of wood in 1635, by Sir Robert Mansell, and a great impetus was given the manufacture by the improvement. In 1673 the first sheets of blown glass for mirrors or windows were manufactured in a factory at Lambeth, established by the Duke of Buckingham, and in which

Venetian workmen were employed. The government at first protected this manufacture by a bounty, and by other measures which reduced the cost of production from twenty-five to fifty per cent., and in consequence various other manufactories were established. Eventually, however, obstacles were thrown in the way of manufacturing glass in England, and especially in the introduction of any new or improved methods, by the establishment of the excise system, and the consequent stationing of government officers in the manufactories. In 1845 the bounties, the aids, and the restrictions were all removed, and under the system of total non-interference by the government, the glass manufacture of England has steadily and rapidly increased. In 1844 the English exports of glass amounted to about one hundred and fifty thousand dollars, and in 1855 they exceeded two million five hundred thousand dollars, and the quality of the English crown glass, or blown glass, is unrivalled.

The chief production of glass in Europe, if not in the world, is carried on in Belgium. In 1854 the amount made there was one fourth more than that in England, being both crown and sheet.

Glass may be technically defined as a transparent, homogeneous, hard product, formed by the fusion of silica with the oxides of the alkaline, earthy, or common metals. It is usually without color, and then resembles rock crystal. It can be colored, however, either by accident or design, with the colored metallic oxides. It is brittle in thick pieces, but in thin plates, or threads, is very elastic. At a red heat it becomes soft, ductile, and plastic. Silica, the basis of all glass, is by itself infusible by any heat which our furnaces can sustain, but its vitreous fusion is easily caused by mixing with it a sufficient quantity of potash or soda, either alone or mixed with lime or litharge. Silica being, as chemistry has shown, an acid, it combines at the fusing heat with these bases, forming a saline compound ; so that glass may be considered as a silicate of certain oxides, in which the acids and the bases exist in equivalent proportions.

If it were possible to ascertain beforehand the quantities or the proportions of the bases required by the silica for its saturation, we could in advance determine readily the best proportions for making glass. But as we have not yet done this, and as it is most probable that the differences of the temperature cause a difference in the capacity for saturation of the silica, and as the properties of the glass vary with the various bases, we must in the present

condition of our knowledge depend more upon experience and practice than upon theory in this matter. The following chemical distribution of the various glasses has been proposed : —

1. Soluble glass ; a simple silicate of potash or soda, or of both of these alkalies.

2. Bohemian, or crown glass ; silicate of potash and lime.

3. Common window glass and mirrors ; silicate of soda and lime ; sometimes also of potash.

4. Bottle glass ; silicate of soda, lime, alumina, and iron.

5. Ordinary crystal glass ; silicate of potash and lead.

6. Flint glass ; silicate of potash and lead ; richer in lead than No. 5.

7. Strass ; silicate of potash and lead ; still richer in lead.

8. Enamel ; silicate and stannate, or antimoniate of potash or soda and lead.

When melted or cooled slowly, the glasses which contain several bases are liable to changes. The silica becomes divided among the bases, making different compounds of definite proportions, which crystallize separate from each other, so that the homogeneity of the glass is destroyed, and it becomes hard, loses its transparency, is fibrous, much less fusible, and a better conductor of heat and electricity. This is called *devitrified* glass, or Reaumur's porcelain, after the discoverer of this process.

The proportion with which silica unites with the alkaline and other oxides, is modified by the temperature at which the union is effected ; the lower the heat, the less silica and the more of the base will be required. If, therefore, a glass which has an excess of alkali be exposed to a higher temperature than that of its formation, a portion of the base will be set free, until a permanent combination is formed according to the temperature. Hence a variety of results will obtain from the same mixture of materials, according to the degree of heat at which they are fused and worked ; and the essential composition should always be referred to the heat of the furnace in which it was made. When a glass has been made at a high temperature, with a considerable quantity of lime, and is afterwards kept for some time fused at a lower temperature, a portion of the lime will form such another combination with the silica as to destroy the transparency of the glass. An excess of silica, with an increased heat, will produce the same results.

The power of glass to resist the action of water, alkalies, acids,

the air, and of light, is, as a general rule, the greater as the heat employed in its manufacture has been higher, as the proportion of the bases is smaller, and as its constituent parts more nearly approach to exactness the equivalent ratios. Glass containing too great a proportion of alkali is partially soluble in water, and, as a rule, the affinity of glass for water, or its hygrometric attraction, is proportional to the quantity of alkali it contains. Air and light operate upon glass most probably by their oxidizing powers. Bluish or greenish colored glass becomes colorless by exposure. If glass containing lead be exposed to air in which sulphuretted hydrogen be present, the oxide of lead is converted into a sulphuret, and the surface of the glass becomes opaque and iridescent. This effect is often seen in stables. The test for a glass vessel to resist most of these effects, is boiling concentrated sulphuric acid in it, or boiling it in the acid: if the glass is good, it will remain smooth and transparent; if not, it will become dim and rough.

After the glass is made, it is toughened by annealing. Without this process it is very brittle; a vessel of thick glass, unannealed, will sometimes fly to pieces by the simple effect of the changes of the atmospheric temperature. Annealing is performed by heating the glass, and allowing it to cool slowly. Frequently the vessels are heated in salt water or oil to as high a temperature as these fluids can contain, and then allowed to cool very slowly. The glass thus treated will stand the variations of temperature within the limits of the heat that has been used.

The following classification of the various kinds of glass may be of interest for comparison with the one already given: —

1. Bottle glass, including the varieties from which hollow vessels and tubes, common bottles, medicine bottles, vials, tumblers, and so on, are made. The dark-colored varieties contain a larger proportion of oxide of iron and alumina, and in none of them is any oxide of lead. White bottle glass is made of silica, soda or potash, and lime.

2. Window glass, including cylinder or sheet glass, and English crown glass, is a silicate of potash or soda, lime, and alumina.

3. Plate glass, which differs from the preceding only in the greater purity of the materials, and their freedom from color.

4. Flint glass, used for grinding, making sand paper, &c., composed of silica, potash, and oxide of lead.

5. Crystal glass, used for optical instruments and table purposes,

consists of silica or boracic acid, potash, and more lead than the preceding.

6. Strass, or the material used for the imitation of precious stones, contains much oxide of lead, and also the metallic oxides used for giving the various colors.

7. Enamel, composed of silica, soda, and oxide of lead, and rendered opaque by the oxide of tin or antimony, which forms a stannate or antimoniate with the soda. Besides, there is soluble glass, being a simple silicate of soda or of potash, or a mixture of the two silicates.

To describe the various operations by which glass is worked, would require so much elaboration, and so many illustrations to make them intelligible, that it is evidently impossible to attempt it here. A visit of an hour to any one of the numerous glass factories, in actual operation, will give a clearer comprehension of the simplicity and skill with which the various processes of manufacture are carried on, than an entire volume could do.

The introduction of the manufacture of glass into the United States was contemporaneous with the settlement of the country. With the establishment of the first colony at Jamestown, Va., in 1607, some of the colonists brought over were glass makers, and the first cargo sent back to England contained "trials of pitch, tar, glass, frankincense, and soap ashes, with what wainscot and clapboard could be provided." At the same time, Captain John Smith, of famous memory, returned "a plain and scholarly answer" by the same vessel to the council in London, who had complained of the want of profitable returns from the colony. From Stith's *History of Virginia* we learn that the glass house stood in the woods, about a mile from Jamestown. Small as it unquestionably was, yet it deserves mention as being the first manufactory erected in the territory of the United States. Stith also informs us that, in 1621, a fund was subscribed to establish a factory of glass beads, to be used as a currency in the trade with the Indians for furs, and a Captain Norton, with some skilled Italian workmen, was sent over for the purpose of establishing this profitable speculation. At the same time, also, a subscription was opened for the purpose of importing women into the colony, so as to give the necessary conditions for the permanency of the settlement, and it would appear that this last venture proved more immediately profitable than the first, the price of maids rising as high as one hun-

dred and fifty pounds of tobacco, and the demand being active enough to quickly absorb the supply.

In the settlement at Massachusetts the first establishment of a glass manufactory is said to have been made at the village of Germantown, in Braintree. Glass bottles alone were made here, and the business was continued until shortly before the revolution, when the failure of the proprietors and the burning of the buildings led to the abandonment of the enterprise, which has never been resumed. In 1639 a glass house was established at Salem, and the court granted "to the glass men severall acres of ground adjoyning to their howses," for the purpose of aiding the enterprise. In 1641 the court further authorized the authorities of the town of Salem to lend the proprietors thirty pounds, to be deducted from the next town rate, and to be repaid by the borrowers "if the work succeeded, when they are able." Bottles and coarse articles of inferior kinds of glass were alone made here. The use of glass in windows was at this time not common in the mother country, and of course it was not in the colonies. One of the leading members of the Plymouth settlement wrote to his friends in England, "Bring paper and linseed oil for your windows, and cotton yarn for your lamps." In 1629 Mr. Higginson, writing from Salem, says, "Bring glass for your windows."

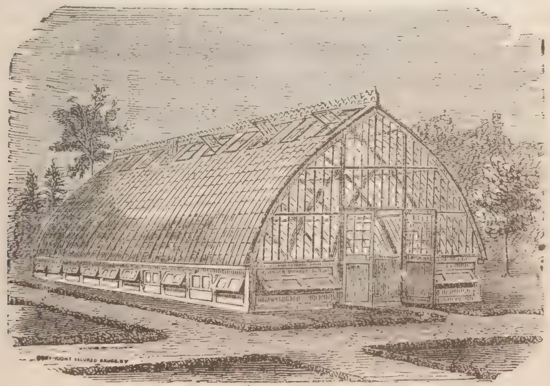
In 1752 the General Court of Massachusetts passed an act granting the sole privilege of making glass in the province to Isaac C. Winslow and his associates. In New York, Jan Smeeds is supposed to have been the first glass maker, and a map made in 1732 indicates the existence of two establishments in the city for glass making. A glass house is also mentioned as existing in Philadelphia in 1683. The business did not, however, assume any importance in the country before the time of the revolution, although glass was one of the articles taxed by the mother country. During the revolution, the importations being suspended, the need of glass was greatly felt. Lord Sheffield, writing when peace was declared, says, "There are glass works in Pennsylvania. Bad glass is made in New Jersey for windows, but there is not any quantity of glass made in America as yet except bottles."

In 1788 the legislature of New York voted a loan of three thousand pounds for eight years to the proprietors of a glass factory near Albany, which, in 1797, became the property of an association known as the "Hamilton Manufacturing Company," and was exempted from taxation by the state for five years. The

glass made by them was in good repute, and the business was actively carried on, producing about twenty thousand feet of glass a month, besides bottles and flint glass, and continued until 1815, when it was discontinued from the exhaustion of the supply of fuel in the vicinity of the works.

Glass works were commenced in Boston in 1787, which in 1800 produced about a hundred thousand dollars' worth a year, and the business is still carried on most successfully in Massachusetts. Connecticut, Maryland, and Virginia also commenced the production of glass during the last century. The first factory commenced in Pittsburg, which is at present a most important centre of the production of glass in this country, was begun in 1795. General O'Hara deserves the chief credit for establishing the business in Pittsburg. Among his papers at his death was found a memorandum to this effect, "To-day we made the first bottle, at a cost of thirty thousand dollars."

The production of glass and glass ware in this country was, by the census of 1860, given as nearly nine millions of dollars, and in 1870 it had reached nearly double this amount, and the business bids fair to increase still further. Though some of the modern processes, as, for example, the making of mirrors, are not yet carried on in this country, and we have to depend still upon Europe for the supply of many of the articles of glass ware to meet the demands of artistic cultivation, yet, in time, so surely has American industry become established, there is no doubt that we shall here, as in other departments of industry, attain the ability of supplying the demand.



FERMENTED LIQUORS, INCLUDING ALE, BEER, LAGER BEER, PORTER, WINE, AND WHISKEY.

BEER AN ANCIENT INVENTION. — TACITUS, CONCERNING GERMAN BEER. — A BEER INCIDENT OF THE LATE FRANCO-PRUSSIAN WAR. — CHINESE ORDINANCE IN REGARD TO THE GRAPE. — HOW WINE IS MADE IN THE CELESTIAL EMPIRE. — CHINAMEN, SATURATED WITH ALCOHOL, BURN LIKE CANDLES. — ALE AMONG THE SAXONS. — THE COMMON "SCRIPTURE DISPUTE" ABOUT THE WORD "WINE." — THE IMMENSE AMOUNT OF MONEY ANNUALLY SPENT IN THE UNITED STATES FOR INTOXICATING LIQUORS. — THE ONLY TEMPERANCE SOCIETY IN ITALY. — THEOCRATIC PUNISHMENTS OF INTEMPERANCE. — MORAL SUGGESTIONS. — INTEMPERANCE A DISEASE.

A DRINK, corresponding to what is called ale or beer, made of barley or other grains, steeped in water and afterwards fermented, has been known among all nations from a very early period. It is generally believed to have been a discovery or invention of the Egyptians. In almost all countries, even including those where wine is a natural production, beer has been a common beverage. The people of Spain and France, and different states of Germany, the inhabitants of India and China, Egypt, Greece, and Abyssinia, have been, and are, beer-drinkers.

Tacitus, in his *History of the Germans* (chapter xxiii.), says the people made drink of barley or other grain, and fermented it so as to resemble wine. He intimates also, that while their food was very plain and inexpensive, there was not the same sobriety in their drink; and that, if any one should give them all they desired to drink, they would be known for their vices rather than their valor. The fondness of the Germans for beer does not appear to have become less since the days of Tacitus. During the siege of Strasburg, in the year of our Lord 1870, some German citizens sent a request to General Uhlrich that he would officially ask the Prussians not to direct their fire towards the breweries.

In China, in different periods of its history, the cultivation of the grape has been forbidden, because the production of other

things was necessary for the sustenance of the people. The immense population of that empire requires the land to be used for the production of grain in its various kinds, so that the culture of the grape is neglected, and wine is regarded as a luxury. Being, therefore, in some respects deprived of grape wine, the Chinese make liquors from corn and other grains, which are used in great quantities. That most common, however, is obtained from the fermentation of rice. It is a kind of beer, and has not an unpleasant taste, though, as generally used in China, is of inferior quality, and not very agreeable, but at the same time not possessing a large amount of alcohol. On one occasion an excellent quality of this rice beer was offered to an English connoisseur in wine, who discovered, as he thought, that it was the produce of some celebrated vintage in Spain. He served it at dessert to some of his countrymen, who pronounced it excellent, and perceived in it the true flavor and *bouquet* of Spanish wines.

In the manufacture of this beer the rice is fermented in large jars; a kind of yeast or leaven is mixed with it, which is called the "mother of wine." This yeast is made of unbolted wheat flour, and prepared with great care, as the goodness of the wine or beer depends on the quality of the yeast employed. It is sometimes made of the flour of oats, barley, rye, and also of peas and beans, to which is often added odoriferous herbs, and fruits dried and reduced to powder. In the northern parts of China this beer is made of millet instead of rice.

A kind of brandy is made of corn, and in some parts of the empire from large millet (sorghum); and by passing it several times through the still, it has the fire and strength of alcohol. These liquors have a very unpleasant taste, which is sometimes modified by bruising in them green fruits and aromatic herbs. The Chinese swallow these fiery fluids with the greatest avidity, and usually take them hot. A recent traveller in China says, "One can hardly imagine what pleasure the Chinese find in imbibing these burning drinks, which are absolutely like liquid fire, and moreover very ill-tasted. But many instances have been mentioned of their having died a fiery death for the sake of it; of men who have absorbed such a quantity of alcohol as to have become fairly saturated with it, and to have, in a manner, exhaled it from every pore. The slightest accident then, the mere lighting of a pipe, has been sufficient to envelop in flames and consume these wretched creatures."

The manufacture of alcoholic liquor from corn was the accidental

discovery of a Chinese peasant in the thirteenth century, though rice beer, or rice wine, was known to that people twenty centuries before the Christian era. While Chinese law prohibits the making of rice wine and other spirits, since the various grains are needed as food for the immense population, yet this law is a dead letter; a fee to the local mandarin removes all difficulty. Though the government sells permission to distil brandy, it is on the condition that no grain shall be used which is not spoiled, and so unsuited for food. But this condition is never regarded. The immense consumption of rice beer and corn brandy has its results in the common vice of drunkenness, which is a prime cause of poverty in China, as in all other countries.

Among the Saxons and Danes ale or beer has been, from earliest times, a favorite drink. It was never wanting at their feasts; and in their pagan faith beer-drinking constituted one of the principal sources of happiness in the Hall of Odin. The modern representation of John Barleycorn on his beer barrel, called by Burns "the king o' grain," doubtless suggests the idea of an earthly paradise to many devotees of Barclay & Perkins, or of "guid auld Scotch drink." In the early periods of English history, ale and bread were considered equally as absolute necessaries of life. This appears from the various ordinances regarding bread and ale passed from time to time to regulate the price of these articles. In that time, when brewers in the city paid twenty-four pence for a quarter of barley, they were obliged to sell two gallons of ale for a penny. Before beer by fermentation converts the sugar it contains into alcohol, it is to a certain extent a nourishing drink; the proportion of alcohol it ordinarily contains is small, varying from three to eight per cent. It holds in solution certain quantities of gum, sugar, and starch, qualities which are nutritious.

In the earliest times beer has been spoken of as possessing intoxicating qualities; it has been called the wine of barley. Writers of the early centuries, describing the mode of making beer, say, "The grain is steeped in water and made to germinate, by which its spirits are excited and set at liberty; it is then dried and ground, after which it is infused in a certain quantity of water, which, being fermented, becomes a pleasant, warming, strengthening, and intoxicating liquor."

Beer is a favorite drink of Germans, and their persistent demand for it has caused it to be extensively manufactured in the United States, though its consumption is by no means confined to

the German population. The number of barrels of fermented liquors, — ale, beer, lager beer, and porter, — returned for tax during the year 1866, was more than five millions; for the year ending June 30, 1871, the number of barrels was 7,159,380, on which was paid as internal revenue the sum of $7,389,141. 73. It is altogether probable that the number of barrels returned for taxation does not represent the number actually manufactured and consumed.

That a drink known for so many centuries, and used by all peoples and nations, is evil in its effects in all cases, can hardly be supposed. And yet the stronger kinds of beer, consumed in large quantities, as it is by the great multitude of beer-drinkers, can have only a pernicious influence on health and morals. Apoplexy and palsy are the common perils of intemperate beer-drinking. The average German beer-drinker is so intellectually confused and stupefied that he is said to laugh at a joke only the day after he hears it. Its tendency is to heavy sottishness and intellectual paralysis. The cost of the beer consumed in the United States, including grain, hops, labor, coal, yeast, etc., cannot be less than thirty-five millions of dollars annually; and for all this expense, with the time lost in beer shops, and the diseases acquired in them, there is really no equivalent.

Wine is the name of a liquor obtained by the fermentation of the juice of the grape. The same name is given to other beverages made by fermenting the juice of other fruits. In the earliest records, in the oldest books of the Old Testament, wine is spoken of as though already known. Of the exact signification of the word, as variously used in the Scriptures, much has been written, and different opinions expressed. Its general meaning however is, the fermented juice of the grape. It is known in all countries, either as a domestic or a foreign production. The geographical range of the grape is very wide, and wine may be made on both continents between latitude 50° north and latitude 45° south. In the warm or hot regions the richest sweet wines are made. The quality of wine is also determined by soil and situation. The percentage of alcohol in pure wines varies from six to sixteen per cent. Where much alcohol is present, they are termed *strong* or *generous* wines; where otherwise, *light* or *weak*; where much sugar is undecomposed, they are called *sweet* or *luscious* wines; where little, they are called *dry* wines.

Chemists are generally agreed that the condition in which alco-

hol exists in the natural product of the first and second fermentation of the grape juice, is very different from that in which it is found when obtained by distillation. The addition of alcohol, or any distilled spirits, is always injurious to wine, destroying its finer qualities, and rendering it decidedly hurtful in its effects. Alcohol or spirits thus added to wine do not assimilate with it, but remain as foreign and unnatural elements. "The alcohol thus uncombined acts on the body in the same way as alcohol simply diluted with an equivalent quantity of water. This is manifest even in the difference of the moral effects of unadulterated wine, in which the spirit is an integral element, and those of the colored liquids, which serve merely as a vehicle for a large portion of alcohol. The pure, light wines of France and Germany produce an agreeable exhilaration of mind, very unlike the mere physical excitement, almost amounting to ferocity, which results from largely brandied wines." It is the universal practice in Spain, Portugal, and Sicily to add brandy to wines which are intended for a foreign market. The wines manufactured in the United States are made unnaturally strong by the addition of distilled spirits and of sugar before fermentation, while the light wines of Europe are the pure, unmixed juice of the grape. The custom, however, is common in all countries of adulterating wine by the addition of spirits and other foreign substances.

"The diseases which attend spirit-drinkers, chiefly disorders of the liver, are commonly met with among the consumers of wines, to which brandy or whiskey has been added, though such disorders rarely, if ever, follow even the intemperate use of pure wine. Much, therefore, of the ill health supposed to follow the habitual use of wines, must be attributed to the alcohol with which they are adulterated, not to the wine itself. It has been held to be inexplicable why a quantity of alcohol, forming an integral portion of some good, sound wine, will not affect the head to the extent or with the rapidity that half the quantity will do when taken pure, or still more rapidly when diluted with water. If the power, which all vegetable acids possess of counteracting intoxication be called to mind, it seems natural that the free acids present in wine should hinder the spirit from acting prejudicially. Tartaric acid, that one most common in good wine, has the greatest power in this respect."

Unfortunately for the consumers of wine, it is difficult to find pure wine in the market, in this or any country. In wine-growing countries adulterated wine is common, pure wine the exception.

The number of gallons of wine made in the United States cannot be known with certainty, since, besides the large product in Ohio, California, Indiana, and Kentucky, more or less is made for domestic use in almost all the other states. The foreign importation of wine for the year ending June 30, 1871, amounted to 9,553,156 gallons, and 5,815,080 bottles, at a cost of $5,573,389. It is not probable that any considerable amount of these imported wines could be called the pure fermented juice of the grape.

Whiskey is a spirituous liquor distilled from rye, corn, molasses, and, it is said, also from potatoes. It is the most common and the cheapest form of intoxicating liquor; and in the compounding and manufacture of other liquors, it enters more or less into all kinds of different names. Of the large amount manufactured in the United States, a part is reduced to alcohol, a part exported to be returned in a few months under the pleasing names of "French brandy" and "Holland gin," etc., but it is principally consumed at home. The number of gallons of whiskey made in the United States, and returned for tax in the year 1870, was 71,337,099. In addition to this amount, there was imported during the same year, under the name of spirits and cordials, 1,667,226 gallons, making a total of more than 73,000,000 of gallons. In the year 1870 the amount received as internal revenue from spirituous liquors, including special tax on distillers, dealers, etc., exceeded $55,000,000. When it is remembered that this ocean of whiskey is for the most part retailed by the glass at an enormous profit, the immense cost, and greater moral waste to whiskey-drinkers, may be understood.

The temperance reform is one of the noticeable features of our modern social life. In Europe, generally, a reformation on the subject of wine and spirit-drinking is not understood or appreciated. When the grape disease diminished the supply of wine and augmented its price, the people formed the habit of using strong spirituous liquors, and much drunkenness was the consequence. A temperance society was organized in Turin in the year 1861, — probably the first and only one in Italy, — not to discourage the use of wine, but of strong liquors. Though men of learning and influence had an active interest in this society, it does not appear to have had any significant results. It is reported of a German clergyman, that in addressing his people on what he called temperance, he said that "ordinarily a man should not take more than two bottles of wine at a sitting; that God had given to but few persons the capacity of taking eight, as he had to him."

The warfare made among us against the use, as a beverage, of all intoxicating liquors, has for many years been earnest, and resulted in great good. A great host of our population, including all ages, have been educated into the sentiment of total abstinence. In carrying forward this reform, doubtless some errors have been committed through excess of zeal. In a fair examination of the teachings of the Scriptures on the use of wine and strong drink, we may not find that their use is denounced as in itself a sin. While no such sentiment may be declared, it may still be true that in millions of individual cases it would be a sin to use the one or the other. We must distinguish between a general principle and individual acts, the character of which must, in many cases, be determined by circumstances. It was the adoption of the principle that the use of wine was a *sin per se,* i. e., in itself, in any circumstances, and absurdly demanding the substitution of water for wine at the communion, that at one time greatly injured the cause of temperance.

Another sentiment clearly taught in the Scriptures is, that *intemperance is a sin,* and under the Theocracy it was punished in the most summary manner. It was the duty of the parents of a rebellious son, who was a drunkard, to denounce him to the elders of his city. And the divine direction was, that "all the men of the city shall stone him with stones, that he die; so shalt thou put evil away from among you, and all Israel shall hear and fear." "Woe to the drunkards of Ephraim, whose glorious beauty is a fading flower. Behold, the Lord hath a mighty and strong one, which, as a tempest of hail and a destroying storm, as a flood of mighty waters overflowing, shall cast down to the earth with the hand; the drunkards of Ephraim shall be trodden under feet." God condemns drunkenness as a sin, for which the drunkard is responsible.

With the plain teachings of the Scriptures concerning the sin of intemperance, we may connect the teachings of all ages and countries that it is the most fruitful cause of all forms of pauperism and crime. Guided by such instructions, it may be said that abstinence from all intoxicating liquor is a safe, and should be adopted as a general rule of duty; and that exceptions are to be made only in favor of the infirm, the weak, and the sick, and even then only in behalf of those whose infirmities do not come of excess or intemperate habits.

Intemperance is a physical disease, and undermines moral prin-

ciple ; so that temperance, like any other virtue, is best promoted by carefully observing all hygienic cases, as well as cultivating the moral sentiments and feelings. The reformation of the thoroughly intemperate is an immense difficulty. To eradicate a vice like drunkenness, is far more difficult than to cultivate the virtue of temperance before bad habits are formed. The homely proverb, that "an ounce of prevention is worth a pound of cure," applies in full force to this subject. Temperance must be promoted by prevention, by a firmer expression of domestic authority in cultivating and establishing the character of children.

In an article where, as in this, the space of the writer is limited, much which bears upon the temperance phase of our subject must necessarily be omitted which might otherwise be introduced with good moral effect. But it will not occur to the reader, because less is herein expressed upon the moral bearings of the use and abuse of fermented liquors than might, under other circumstances, have been offered, that therefore the writer's zeal in the cause of temperance, after an advocacy of total abstinence from all intoxicating drinks for nearly thirty years, has in the least abated.

JOHN B. GOUGH.

SCREW-WRENCHES AND THEIR MANUFACTURE.

DEFINITION OF A WRENCH. — THE EXTENT TO WHICH THEY ARE USED. — THE HISTORY OF THE SCREW-WRENCH. — A. G. COES AND CO.'S SCREW-WRENCH. — MERRICK'S PATENT. — A. G. COES'S PATENT. — IMPROVEMENTS UPON IT. — THE MACHINERY USED IN WRENCH-MAKING. — A. G. COES'S IMPROVEMENTS IN IT. — THE "HEADER." — THE "UP-SETTER." — A. G. COES AND CO.'S ESTABLISHMENT. — THE EXTENT OF ITS BUSINESS. — MR. COES'S PERSONAL HISTORY.

A WRENCH is an instrument for giving a wrenching motion to a bolt or bar, and is used for twisting out screws. A screw-wrench is one in which the jaws used for taking hold of the square head of the screw or bolt, or the nut by which it is fastened, are made adjustable to the required size by means of a screw, which moves one of them. The extent to which machinery is used in this country, is shown by the fact that the manufacturers of screw-wrenches, the use of which has been introduced by the necessity incident to it, has become the important industry it now is. The number of screw-wrenches made annually in the United States is estimated at about a quarter of a million. These are of all kinds, good, bad, and indifferent.

With the exception of perhaps twenty thousand, the rest of this supply is produced by the house of Messrs. A. G. Coes & Co., who thus rank at the head of this industry, and control, through their patents, the manufacture of the only really valuable wrench, which is known in the market as the "Coes Wrench."

The history of the screw-wrench extends back only to the 17th of August, 1835, that being the date when letters patent were granted to Solyman Merrick, of Springfield, Mass., for a screw-wrench, which is now almost entirely superseded, where reliable wrenches for constant use are needed, by the improved wrench made exclusively by Messrs. A. G. Coes & Co., under their patents relating to the form of the wrench, and to the improved machinery by which they are made.

Before Mr. Merrick's invention, many attempts had been made to produce a practicable screw-wrench, and not a few of the devices arrived at worked passably well. But they all failed in some point of reaching even the partial perfection which his attained, and were eventually abandoned. Mr. Merrick's patent secured the mode of connecting and operating the screw upon the main bar of the wrench. Though this was a very valuable improvement upon anything previously produced, yet it required the expenditure of much time and money to get it introduced, the chief difficulty in its way being the fact that the instrument was constructed upon such principles that there was no certainty of perfection in its construction. One good wrench of this kind was no guarantee to the purchaser that the next one would be equally good. The screw running upon the bar, upon the sides of which the threads were cut, made it necessary that not only the threads of the male and female screw should be accurately cut, but also that the material of which the nut and the bar were constructed should be of the finest quality, and be forged in the best manner, to prevent the bending of the bar by the strain necessarily put upon it, so that the nut should not "bind," or work with great difficulty, or not at all.

Though eventually this screw-wrench of Mr. Merrick's obtained a large sale, yet it was not large enough to remunerate him for the time and expense of its introduction, and in 1848 an extension of the patent was granted him. By the introduction of this screw-wrench the public, however, was habituated to their use, in the place of the devices previously provided for this purpose, and the inventive genius of others was excited to attempt the construction of some other implement which should more perfectly subserve the purposes for which it was intended, by being less liable to become wholly or partially inoperative by severe usage.

In 1841 a patent was granted for a screw-wrench which obviated these objections, and also in which the position of the movable screw, running on the bar, and requiring for its operation both hands of the person using it, was supplemented by a rotary screw, upon a fixed axis, and so constructed as to drive the movable jaw by the simple application of a "rosette," or a corrugated head of the screw, by the thumb of the operator, as he holds the wrench in his hand.

This patent was held by Messrs. L. & A. G. Coes, of Worcester, Mass., and under it they for many years controlled the manu-

facture of this improved wrench. As described in the letters patent, this improvement consisted in "the moving of the sliding jaw by a screw, combined with and placed by the side of and parallel with the bar of the permanent jaw and handle, when the required rotation for sliding the jaw is given by the head or rosette, which retains the same position relatively to the handle during the operation."

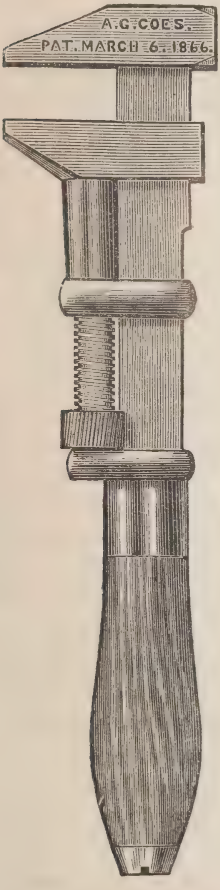
On the expiration of this patent it was extended for seven years, and re-expired in 1862. Since that time several manufacturers, in various parts of the country, have attempted the production of this wrench; but though in some instances possessing large capital, they have invariably failed to continue their operations long, partly through the want of the requisite mechanical skill, but mainly from the impossibility of competing with the established reputation of the Messrs. Coes, who had gained the public confidence in their wares. The signal failure of these attempts is an evidence of the consideration which conscientious workmanship receives from a discriminating public.

Valuable, however, as was the wrench as manufactured for some time after the expiration of the patent by the Messrs. Coes, yet it has been greatly improved, and particularly by a patent obtained in March, 1866, by Mr. A. G. Coes, the principal of the firm of A. G. Coes & Co., the successors of the original firm of L. & A. G. Coes which was dissolved some years ago by the withdrawal of Mr. L. Coes from the screw-wrench business.

In this improvement the haft or handle was relieved from the back pressure of the rosette screw, and the instrument thus rendered more durable, and less liable to be deranged. This improvement is so great that a screw-wrench is not now considered desirable without it, and consists in a ferrule so constructed that when the handle is thoroughly fixed to the tang, or bar, it is held by an eccentric cap affixed to it, in a slot slightly cut in the tang or bar, so that the ferrule cannot be forced back by any amount of strain upon the movable jaw of the wrench.

The next improvement upon the screw-wrench was that known as the Richard patent, which is owned by Messrs. A. G. Coes & Co. A difficulty had always been experienced with screw-wrenches of any form in so constructing the bar that, under great strain, it would not be liable to bend, or perhaps to break. Experience had shown that the chief strain came upon the bar at a point between the jaws and a distance from the fixed jaw, to be determined by the

size of the nut to be turned. To remedy this, the bar was made, under the Richard patent, broader between the jaws, while it remained of the same size through the rest of its length. This simple improvement overcomes the difficulty, and makes the screw-wrench a much more valuable utensil than before.



SCREW-WRENCH.

It was at first thought that making the bar of two sizes, as thus proposed, would be so difficult an operation as to render it financially impossible to manufacture the screw-wrench in this form, but Messrs. A. G. Coes & Co. soon invented machinery for this purpose.

A still further improvement in the screw-wrench was patented in May, 1871, by Mr. Aury G. Coes, the senior partner of Messrs. A. G. Coes & Co., by which the wrench is enabled to receive a larger-sized nut than it otherwise could, and by which, also, the clasp strap of the movable jaw is prevented from "binding," or becoming set upon the imperfectly cut portion of the screw thread, as was formerly of frequent occurrence. These two important improvements were obtained by counter-boring the screw opening of the movable jaw, for a slight distance, the screw opening of the jaw being extended sufficiently beyond what was customary in the old form to secure a like length of thread.

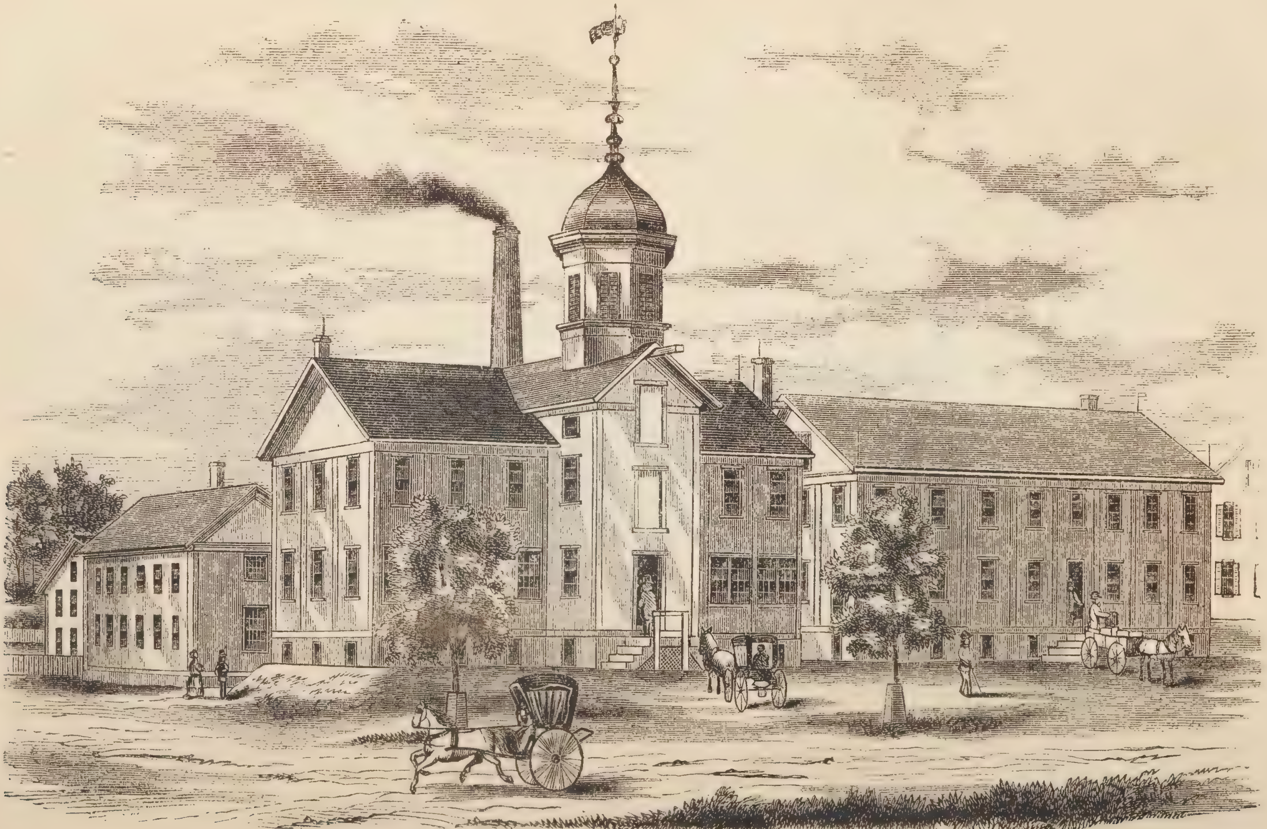
These three improvements, that by which the back pressure upon the handle is prevented, the widening of the bar between the jaws, and the counter-boring of the movable jaw, the patent rights to which are held by Messrs. A. G. Coes & Co., enable them to control the market for the improved screw-wrench as thoroughly as the original firm, of which they are the successors, controlled that for the original screw-wrench; and these improvements, as they have brought the screw-wrench to perfection, may be said to have inaugurated a new era in its history.

In the manufacture of screw-wrenches but little machinery of a peculiar nature has been heretofore used, but such as was in use was the invention of Mr. A. G. Coes. In July, 1870, however, he patented an important machine, called a "header," for forging the heads of wrenches, by which two heads can be formed in the time which it formerly took to make one by hand. This machine operates with a pair of opening and closing jaws, operating in unison with a head drop, by which the head is formed, and prevented from spreading laterally, while the rapidly-driven drop beats upon the upper end with great force, forming the head with a few blows.

Another important improvement in the machinery for the manufacture of screw-wrenches, patented by Mr. A. G. Coes in April, 1871, is called the "up-setter."

The wrench bar had heretofore been prepared for heading by rolling or forging down under a trip-hammer to the required size, which was a slow and expensive process. By the new "up-setter," a bar of iron, heated to a red heat, and of the proper size, is instantly formed into a wrench bar-head, having the requisite evenness at its corners, and without a surplus of material, thus obviating the necessity for forging or rolling down the bar of iron. This machine is simple, consisting principally of a pair of dies and a "plunger." The dies hold the iron in position, and are so constructed at their upper ends as to allow the iron to expand to the proper dimensions under the pressure of the plunger. By the use of this machine the production of wrench bar-heads is increased at least threefold with the same expenditure of power and time.

The establishment of Messrs. A. G. Coes & Co. is situated in Webster Square, in that part of Worcester, Massachusetts, known as New Worcester. It was here that the business was originally established by Mr. A. G. Coes, in connection with his brother, nearly thirty years ago. The buildings have been enlarged to meet the growing needs of the business, and now form the only establishment in which the invaluable "Coes Wrench," with its improvements, which add at least fifty per cent. to its value, is manufactured. Though attempts have been made to compete with them, even by using a similar name in their manufacture, yet the superiority of the wrenches made by Messrs. A. G. Coes & Co. have led to their general use, not only in this country, but also in the West Indies, Australia, South America, and Europe.



SCREW WRENCH MANUFACTORY, A. G. COES & CO., WORCESTER, MASS.

Mr. Aury G. Coes, the senior member of the firm, by whose industry and inventions the screw-wrench manufacture has been elevated into one of the leading industries of the country, is highly esteemed as a citizen of Worcester, having filled, with the perfect satisfaction of his townsmen, several civic positions, and having also been elected by them to serve in the state legislature.

WOOLLEN MANUFACTURES.

THE INSPECTION OF FLEECES. — DIFFERENT KINDS OF WOOL, AND THE DIFFERENT USES TO WHICH THEY ARE PUT. — THE SORTING OF WOOL. — PROCESSES OF MANUFACTURE. — WOOL-DYEING. — WORSTED. — THE LONG-WOOL INTEREST. — AMERICAN INVENTION OF WOOL-WORKING MACHINERY. — STEADY PROGRESS OF THE ART IN THE UNITED STATES.

The fleece, when it comes into the wool merchant's hands, is subjected, first, to a general division, which determines the class of goods for which it is best adapted; then, in the hands of the manufacturer, it is very carefully examined and sorted. The three leading classes of wool are, first, felting wools. Their peculiarity consists in the serrations along the edge of the fibre. Some wools have very little of this, and felt very imperfectly. The best class of goods for gentlemens' wear — broadcloths, cassimeres, and beavers — are manufactured from felting wools.

Second, combing wools. The object in handling and working felting wools, is to pack the fibre as closely as possible. In the treatment of combing wool, the object is right the reverse — to work out the fibres in long, silk-like threads, and thus produce a fabric resembling silk goods. From combing wools are made a large class of fabrics for ladies' wear, as poplins, mohairs, and alpacas.

Third, wild and hairy wools. These come from Australia, Mexico, and South America. Wool in those warm countries, adapting itself to the climate, does not compose the fine, oily mat for the protection of the animal from cold and wet which we find on the sheep of England and Germany. It falls away from the belly and legs of the animal, whose back and sides only yield a light fleece of a coarse and hairy nature. This is used in the lower grades of blanketings, and extensively in weaving carpets. Between the felting wool and the combing wool proper is a great variety of mixed or graded fleeces, adapted to the production of

white bed-blankets, kerseys, linseys, flannels, and tweeds. Quite the majority of American mills are engaged upon the latter class of manufactures.

When a bale of felting wool is opened at the factory of a weaver of cassimeres or doeskins, the first operation is the *sorting;* and here great judgment and long experience are demanded. The loom has been brought to such perfection that the different faces that can be given to goods afford a wonderful variety of appearances, from material which is practically the same in all. Thus alternate groups of threads may be lifted so as to make ribbed goods; they may be lifted in a curious alternation, so as to give a basket or braided appearance. The part of the fleece that is thus thrown to the surface, or makes the face of the goods, is the best in the fleece. The sorter rolls out the fleece on a table, sloped a little towards him, and lays his hands first on the wool that covered the sides and shoulders of the animal. Each bale of wool, as well as the wool from the different parts of the sheep's body, affords many different degrees of fineness, softness, strength, color, cleanness, and weight; and the sorter, beginning with the best wool in the fleece, separates it into prime, choice, super, head, downrights, seconds, fine abb, coarse abb, and tags. This assortment is of great importance, and on it is based the reputation of a mill for producing high grades of goods with uniformity.

The manufacturer must have nice judgment in deciding what he can do with the various bins of assorted wool. In the winter and spring, for instance, he uses his prime and choice to compose the face of light summer goods, as fancy cassimeres. This gives him a large supply of downrights and seconds, of which he can make the body of heavy goods for cold weather. Thus it is convenient and profitable to change the make of goods from time to time in the same mill, as different sortings are the better adapted to this or that fabric.

The most thorough coloring is obtained when the material is dyed in the wool. A preparation from indigo is found to make the best basis of color. But the wool must be well cleansed before it is dyed. The old mixture was composed of strong soap-suds, with some animal acid as the uric. The quantity of soap absorbed by wool is very great. England consumes fourteen million pounds of it annually in scouring her wools.

In visiting a wollen mill, it is not often that the dye-room is opened to inspection. Each large mill has its secrets and peculiar

processes, on which, perhaps, the fame of their cloth is based. Before the development of that wonderful and beautiful series of colors from coal-tar, known as the annaline dyes, it was held that blue was the most durable of all the colors given to broadcloth. It is supposed that less damage to the fibre and soundness of the wool is wrought by indigo rather than by any of the red and dark colors. The usual proportions for a good black dye, for every hundred pounds of wool previously indigoed, are five pounds of copperas, five pounds of nutgalls, bruised, and thirty pounds of logwood. The wool is first dipped in the solution of nutgalls, then into the logwood and copperas. Pyrolignite of iron is used to set or fix the black dye.

Now commences the long and complicated process of converting the wool into cloth. The first step is to thoroughly pick the locks apart, and separate all sand, dirt, and foreign matter. It is thrown upon an endless apron, which feeds it into a cone-shaped mill, having spikes on the inside of the cone and on the axis or shaft that revolves with much rapidity. These revolving spikes pull and pick the wool very thoroughly, and a blast of air from a fan carries away the dust. It now passes to the carding machines. These consist of large cylinders, belted with leather, which is filled with fine steel wires curved all one way. Within a fraction of an inch of one cylinder another revolves in the opposite direction, equipped with little wire teeth, which are bent in the opposite direction from those on the first cylinder. The wool is thus pulled into a fine film, and wound around the cylinder; but at the end of the machine a comb, with a rapid up-and-down motion, takes the carded wool from the cylinder, and guides draw the fibres into a delicate, rope-like bundle of very loose fibres, having hardly any tenacity. This is the penumbra, from which the even, compact thread is to be condensed by the spinning-jenny. Just before entering the carding mill the wool is sprinkled with olive oil. The slender pipe or roll of wool, as it comes from the machine, is twisted into a soft, spongy yarn, and this is twisted hard, or slack-twisted, according to the requirements of the fabric in hand.

No verbal description of a spinning-jenny and of a power loom, with its various and most complicated outfit, can be made intelligible. When two or more different sorts of threads are ready for the loom, it will be sufficient for our present purposes to say that there are contrivances in weaving that will throw the fine and hard-twisted yarns to the face of the web, and repress the coarser and

softer twists to the back of the cloth. In other looms both sides are treated impartially, and a garment made of this class of woollens, of which Melton is an instance, can be turned, and will give as good service on the under as on the upper side. In some looms all threads of a certain color can be carried at the face, while the reverse is quite different — almost the opposite in color.

But the best class of woollens are only half made when the piece is unwound from the loom-beam. Fulling or felting is the next important process; and here the need for careful sorting before the wool is handled becomes apparent. A good felting wool has about twenty-five hundred spurs or notches to the inch, when examined under a good glass, while in an inch of Leicester wool there are only eighteen hundred spurs. The process of felting consists in rubbing, moulding, and pressing these fibres, so the spurs will interlock and become fixed. Superfine cloth has four pullings, of three hours each, the layers of cloth having a thick solution of Castile soap between them. When cloth is well pulled, the fibres of the web and woof are inextricably united, and it will not unravel when cut on the line of one of the threads, but is alike in every direction, having the uniform texture and soft feel of chamois leather. When the fabric is well fulled, the fibre of the wool is pulled up by a peculiar process, called teazling. Teazles are seed-pods of a weed, called *dipsacus,* in botany. It bristles with points like a thistle-burr, but these points are curved over a little, and are very stubborn at the end. When a number of these teazles are set in a cylinder, and the cloth slowly drawn over them, the points lift the fibres of wool; but if they pick up a thread which offers considerable resistance, the point of the teazle gives way or breaks. If steel points are used, they pull the threads out, or pick holes through the cloth. The teazle leaves a rough, unsightly surface on the cloth, which is removed by shearing. Two keen steel edges on a cylinder are made to play near each other, like the limbs of a pair of shears, and under the point of contact the cloth is slowly drawn. Fine broadcloth is teazled and shorn several times, till it presents a very short and perfectly uniform nap. Then it is subjected to the action of steam, and afterwards pressed, to give it lustre and compactness. To review this process by which the best cloth is made: there are nine steps or stages in it, and at some grand exhibitions manufacturers have displayed nine parcels of wool, or specimens of work, in the production of broadcloth, as follows: —

First, a good specimen of felting wool, scoured white. Second, the same after the indigo bath, presenting a bluish tinge. Third, dyed quite black, with nutgalls, logwood, and pyrogallic acid. Fourth, carded in plaits or rolls, as it comes from the cylinders of the carding-machine. Fifth, spun and ready for the loom. Sixth, just as it comes from the loom. Seventh, after being felted or fulled. Eighth, after the nap is raised by teazling. Ninth, sheared, steamed, brushed, and ready for the tailor's shears.

These steps are much abridged in the manufacture of flannels, blankets, and tweeds. In these fabrics both sides are alike, the loom is simple in its construction, and the goods are ready for wear as soon as they come from the loom, except that in the manufacture of blankets fine-toothed cards are used to raise the nap or down.

Worsted is a thread spun of wool that has been combed, and which in the spinning has been twisted harder than ordinarily. The word originated from Worstead, a village in Norfolk County, England, where the manufacture of this article was first introduced.

The reason why a long-stapled, strong and firm, though somewhat coarse wool, is best adapted for this class of cloths is, because they require a fine, smooth yarn, with no tendency to shrink or felt. The wool is washed and willowed, as for making pulled cloth. Then follows the combing process, the object of which is to draw the fibres out in parallel lines or threads. It was formerly done by hand; but forty-two years ago John Platt, of Salford, invented a comber, which has been improved and modified, till it does the work expected of it with great perfection. No verbal description of a machine so complicated can be made intelligible. The work on alpacas and mohairs is expended mostly on the yarns, to make them even, regular, and glossy, for weaving is the last operation on goods of this class.

The long-wool interest, as it is called, in distinction from felting wool, is comparatively new in this country, having been developed since the war; but the manufacturers in this line have made wonderful advances, and we can show lustre goods as elegant in their finish as any from the French looms.

Erastus Bigelow, of Boston, has done more than any American, as much as any one inventor that ever lived, to bring woollen manufactures to their present perfection. He has taken out more than fifty distinct patents for devices and improvements in looms and other machines for handling wool. His chief improvement is

in a loom for weaving Brussels carpeting. Previous to his invention, a boy was required to stand by the old loom, and ply the brass wire or rod, over which the threads are looped, to form the pattern peculiar to the Brussels style of tapestry. He invented an automatic loom, by which Brussels carpeting can be woven with great rapidity and perfection. His loom has been adopted in the English mills, and there are several factories in this country where the more expensive sorts of carpeting, as Brussels, Wilton, and Axminster, are made with great perfection and beauty of pattern.

Workmen and workwomen in woollen mills are well paid. The care and skill required in many stages of the process demand operatives beyond the average in steadiness and discretion. In broadcloths especially there is room for indefinite development and improvement at almost every stage of production. The sorting can be made more nice and perfect ; the washing and removal of the animal oil can be more thorough ; the spinning can be carefully adjusted to the nature of the wool, and the quality or grade of goods in which it is to be wrought. In the fulling, and shearing, and steaming, also, the most careful manufacturer will find that, as perfectly as he may conduct his operations, some bolt that he may see at an importer's, made in the west of England, will surpass his best efforts in the compactness of the fabric, in the shortness of the nap, in the smoothness of finish, and in that remarkable quality of the best English goods, the freshness of their appearance after months of constant wear. But year by year our mills are gaining on the west of England in the excellence of their goods, and there is not sufficient excuse for the too prevalent idea that a gentleman cannot array himself in first-class garments unless made up by a tailor that imports his materials. We have no class of men more intelligent, more enterprising, or more patient than our woollen manufacturers, and their greatest drawback is the irrational prejudice that, because we make great quantities of cheap goods for popular service, our mills cannot turn out a first-class diagonal, or cassimere, or beaver, or Melton.

MODERN INVENTION IN DOMESTIC INDUSTRY.

ANCIENT TAMBOURING APPARATUS. — THE MACHINE FOR EMBROIDERING. — MOSES'S ACQUAINTANCE WITH EMBROIDERING. — THE EMBROIDERING MACHINE THE PRECURSOR OF THE SEWING-MACHINE. — INDUSTRY IN THE FAR EAST IN MOSES'S DAY. — THE INDUSTRIAL ADVANCE OF THIS CENTURY. — "OUT WEST," "DOWN SOUTH," "UP EAST." — A COMPARISON OF THE PRESENT WITH COLONIAL TIMES. — THE TELEGRAPH AND THE POST-BOY. — BOSTON IN 1630 AND IN 1790. — CINCINNATI IN 1788 AND IN 1850. — CLEVELAND IN 1796 AND 1860. — ITS GEOGRAPHICAL ADVANTAGES FOR TRADE. — ITS RAILROAD FACILITIES. — ITS MANUFACTURES. — THE WILSON SEWING-MACHINE COMPANY. — THE EXTENT OF THEIR BUSINESS. — THE PRINCIPLES UPON WHICH IT IS CONDUCTED. — MR. WILSON A REPRESENTATIVE MAN.

Probably, in the earliest days, whenever sewing with the common needle first became onerous to the housewife,—or the houseband [husband], it may have been, for perhaps domestic relations were better balanced than now, and domestic duties more equitably divided, — probably human hopes longed for and human genius attempted to devise some plan of sewing more speedy and easy than that. Thus the ancient tambouring apparatus, employed for embroidering figures upon fabrics, to be afterward removed and sewed upon others, was an example evincing a general desire in the direction of the sewing-machine, and combined the eye-pointed needle with other devices now common in sewing-machines. Machine embroidering with a large number of needles seems to have been invented about the beginning of the present century, by John Duncan, whose process was patented in May, 1804. He used barbed or hooked needles, attached in a straight line to a horizontal bar; the forward motion of which carried the barbed ends all through the fabric together, and each being then supplied with a thread by a feeding-needle, the reverse motion took them all back, with the loops of the thread, which passed through, and secured, the loops of the previous stitch. Patterns were worked by a sliding motion of the fabric with its vertical frame, either to the right or the left, up or down, the movement being produced either by screw spindles,

worked by hand, or pattern cams cut to the required design. This may be considered the first important step made in embroidering machinery, which was afterwards carried to great perfection in the machines of M. Heilmann.

The embroidering machine as the precursor of the more modern sewing-machine is worthy of more extended description, both historic and mechanical, than we shall be able to give it in this article, and is, as to its influence in the fine arts, of no less importance than the sewing-machine. On first reflection it would seem strange that the machine for producing ornamental work or fabrics should have preceded that, in the line of invention, of the machine designed for more practical and necessary purposes. But the savage, while he simply folds about him his rude garment of a bullock's hide, if indeed he wears any, elaborates and profusely adorns his cap with feathers, paints his face, or tattoos his limbs, etc. The march of the race from barbarism to the highest degree of present civilization is perhaps as signally expressed in the matter of its personal adornments as in any other way. In barbarism gewgaws of all possible sorts constitute the chief movable property of tribes and individuals, worn without any regard to what we call "good taste," and with whatever profusion the individual's ability will permit. In semi-barbarism less ornamentation attends the individual, as well as the tribe or nation in its public parades, its religious demonstrations, its "going forth to battle," etc., than distinguishes the wholly barbaric tribes. And as the race moves on it divests itself of a portion of its ornaments, and turns its energies to the possession of more substantial and useful wealth; and in most enlightened civilization we observe but little of personal adornment, especially among those really advanced in literary culture, or winning the great triumphs of modern progress. Indeed, the ornamentation of the person to any great extent has come to be regarded by the more refined society of these days as the badge of ill-breeding and lack of brains. The fop and the silly woman, the gambler and pot-house politician, the flunkey and the bar-tender, the sporting fraternity, and people of their kind, are distinguished by their love of display in personal adornment, — vain of their finger-rings, ear-rings, pins, and gaudy dresses, while the earnest, intelligent, honest woman and philosophic man eschew these things altogether. Indeed, the skilful reader of human nature needs no better evidence of a man's or woman's lack of the better characteristics of the heart and brain than the showy ornaments they wear. In fact, he may read the

comparative moral and intellectual merits or demerits of people by noting the different degrees of their ornamentation.

But to return from this digression upon the moral significance of "finery," to the history of embroidery, — the machinery to accomplish much of which was the forerunner of that great power of these times, the sewing-machine.

It appears that from the earliest historic times embroidery received the attention of the "powers that be." Indeed, every earnest Jew and Christian cannot but believe that God himself was not only not insensible to the pleasing influences of embroidery, but that he took special care to cultivate a love of it in his creatures. It behooves us then to speak of the embroidery of the days of Moses with respect, if not admiration. But it is greatly to be feared that much of the embroidery of modern times has not enjoyed supreme guidance in its manufacture; and the same may be said of not a little of our clothing, shirts, etc.

In Exodus, twenty-fifth and twenty-sixth chapters, we find that the Lord spake to Moses directly upon this subject of embroidery, among other things, so far as it related to the ornamenting of the Tabernacle then making. There are people of doubting minds, Atheists and Infidels, who profess to disbelieve this record of God's personal communication with Moses. But the doubts of these men can never disturb the fact.

God's special interposition in the matter of embroidery gives to the writer a peculiar charm in its discussion, and we shall be pardoned by our readers, we trust, for quoting somewhat from the authority to which we have referred. After instructing Moses how to have the Ark of the Covenant and sundry candlesticks made (Ex. xxv.), the Lord proceeded to give him directions how to adorn the Tabernacle. The chief regret of the student of history would naturally be, that at that time they had no such thing as an embroidering or sewing machine, which would have greatly aided the parties, the superintendent and workmen alike, and shortened their day's work by several hours perhaps. But it could not be expected that anybody, not even Moses with all his sacred inspiration, could be master of everything.

In his orders to Moses, the Lord made detailed specifications of how he would have the Tabernacle adorned (Ex. xxvi.): "Moreover, thou shalt make the Tabernacle with ten curtains of fine twined linen, and blue, and purple, and scarlet: with cherubims of cunning work shalt thou make them.

"The length of one curtain shall be eight-and-twenty cubits, and the breadth of one curtain four cubits, and every one of the curtains shall have one measure.

"The five curtains shall be coupled together one to another; and other five curtains shall be coupled one to another.

"And thou shalt make loops of blue upon the edge of the one curtain from the selvedge in the coupling; and likewise shalt thou make in the uttermost edge of another curtain, in the coupling of the second.

"Fifty loops shalt thou make in the one curtain, and fifty loops shalt thou make in the edge of the curtain that is in the coupling of the second; that the loops may take hold one of another.

"And thou shalt make fifty taches of gold, and couple the curtains together with the taches; and it shall be one tabernacle."

We have not space to quote here in extent from the exceedingly interesting and spirited history of Moses's business conferences with the Lord,—suffice it that extended instructions followed as to how to adorn the outside, etc., of the Tabernacle by those arts in which the embroidery machine and its "regular descendant" the sewing-machine would, if then in existence, have played a chief part, and have entered into sacred history, as well as candlesticks and like unimportant wares. It is greatly to be regretted that the East of those days was not blessed, like the West of these times, with such machines,—beautiful emblems of the progress which the race has made since Moses's time. But our confined space forbids our dwelling in comment upon either the wants or glories of the East, either with or without its Moses. Not only Western Europe with its teeming nations has become known to history since his day, but another West, in the shape of two great continents, has been opened to races which were allied to those over whom Moses ruled. Our own Republic takes the lead of the world in active business and mechanical enterprise, and the most noticeable feature of the industrial advance in the United States during this century lies in the rapidity with which an organized and highly differentiated society has been established in "the West." Though this term, like that of "down South," or "up East," is indefinite, and has come to be applied in turn to every section of the country lying between the Atlantic sea-coast and the Pacific, yet the rapidity with which in this century it has leaped from the borders of the settlements at the close of the Revolution is astounding, and wildernesses larger than many of the countries of

Europe have been redeemed, making "out West" no longer refer to the borders of the Ohio, or the unsettled shores of Lake Erie, but to the outskirts of a region which was unknown and unexplored even fifty years ago, showing that in civilization, as in everything else, the world has entered upon the railroad era of progress. When we compare the century and a half which it took for the settlements upon the Atlantic sea-coast to extend towards the inland, not more than a few hundred miles, with the rapidity with which west of the Ohio River growing cities and a well-cultivated country have been created from a wilderness, we see the difference between the activity of the social forces at work in the world of to-day and those which were in action at the time of the settlement of the colonies.

The isolation of a society which, by the want of means of communication, was limited to the narrow circle of its own members for subjects of interest and the stimulants to social activity, has now been replaced by a condition of things in which the daily journals give the news, not only from all over the country, but from all round the world. The telegraph has replaced the post-boy, and news from Europe is old in a day, instead of being fresh in three months, as it was at the commencement of this century. With the railroad, also, the Pacific and Atlantic coasts are brought practically into more immediate connection than Boston and New York were fifty years ago.

In fact, the material civilization of the present has made it possible that a single nation, composing an homogeneous social and political organization, should extend through the wide expanse of our national domain without the danger of disintegration and falling to pieces for want of any close connection between its parts, which has heretofore in the history of the world led to the disruption of all attempts at universal empire. It has been shown elsewhere in this work how slow and difficult was the process of establishing the various staple branches of manufactures in the early days of the colonial times; but by the gradual process of differentiation the materials have been prepared, and the forces necessary for their organization have been generated, so that now the building of a city appears to be hardly a greater undertaking than the construction of a single modest house was to the settlers at Plymouth.

As a child, who with difficulty has mastered his figures, and obtained a comprehension of the simplest rules of arithmetic, comes finally by practice to be able to apply them to the calculation of the earth's orbit, and predict the future motions of the solar system, so

has the nation by slow steps learned the use of its faculties, and obtained the experience in their use which enables it to extend the complex civilization of the present with greater ease than it was formerly enabled to clear and stock a neighboring farm. Boston was settled in 1630, and in 1700 contained only about seven thousand inhabitants. In 1790 the first national census showed the population amounted to 18,038 persons, it having in ninety years less than trebled.

For a comparison with this growth of the chief city of New England, we will take a city in Ohio, which at the beginning of this century was about the limit of "the West," and which as the first State lying in the line of the course of the westward emigration of free labor, which, avoiding slavery, has rolled in a steady stream to the Rocky Mountains, building up cities, and carrying with it all the appliances of civilization, was the first settled State of the West, — Cincinnati, which was first laid out in 1788, had in 1800 only four hundred inhabitants, the disputed title to the territory which then formed what was called the Northwest Territory having proved an obstacle in the way of its rapid settlement. With the settlement of this question, the West was opened freely to the tide of emigration which flowed from the Eastern States, caused by the attractions of the new life of a new country, and the opportunities it afforded for enterprise, together with that from Europe, composed of those who looked with hope to the new republic, and sought to live where the simple right of political representation which it required a revolution to obtain at home was freely offered to any one who desired it.

Fifty years after the opening of this century, less than the time allotted for two generations, the population of Cincinnati had increased from four hundred to nearly two hundred thousand persons, had built nearly a thousand steamboats, and shipped yearly nearly one hundred millions of dollars' worth of produce, importing nearly eighty millions of dollars' worth of materials from abroad. Beside this, the industrial enterprise of the city had built up a manufacturing interest which produced an aggregate of over fifty millions of dollars' worth of various articles, and the city has established railroad connection with more than ten thousand miles of railroad leading directly to or through it. Nor was all this done at the expense of the rest of the State; on the contrary, the freedom of our political conditions leads to the mutual interdependence of the commercial and agricultural interests. Our cities are not founded, as those of

Europe frequently are, upon the possession of monopolies created by artificial restraints upon commerce or manufactures, or to subserve some political purpose, but are as naturally the outgrowth of the increasing activity of the whole people, and serve their purpose as the heart fulfils the necessary functions in the circulation of the blood.

The growth of the second city in Ohio is perhaps a better instance even than Cincinnati of this. Cleveland, situated upon the southern shore of Lake Erie, and upon both sides of the Cuyahoga River, is celebrated among tourists as one of the handsomest and finest located cities of the Union. It was laid out in 1796, and at the end of this year its population amounted to three persons. In fifty years, however, it numbered nearly twenty thousand, and this is more than doubled in the last census. Before the advent of railroads, Cleveland was a centre of the canal system of Ohio, and has been prompt to assume the same position in the railroad era of intercommunication. The territory in which it is situated having been originally owned by Connecticut, and known as the Western Reserve, the chief portion of its population has been derived from New England, and the increased advance they have made industrially and in the culture of civilization over that which their ancestors made in the same time shows how much greater are the social forces acting in the world to-day than then, and how much more intense is their action.

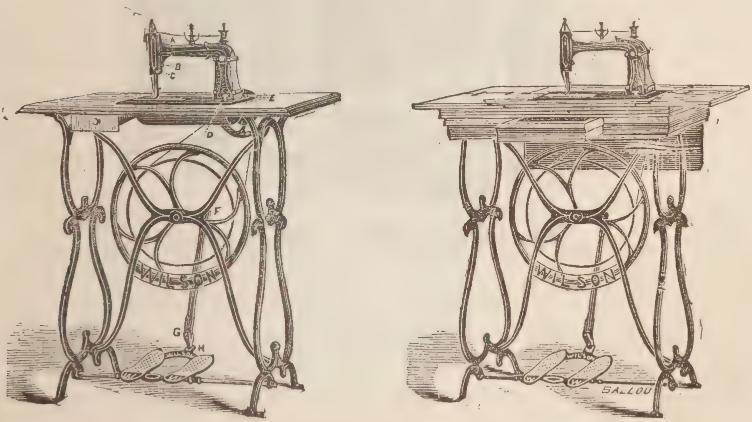
With its advantages of position, and the natural elements of wealth, of coal and iron, which surround it, the enterprise of its people has turned them to the best advantage, and Cleveland ranks high among the manufacturing centres of the West. Not only are the staple manufactures of the raw materials furnished by nature carried on extensively, but the more accurate processes necessary in the production of machines, into which skilled labor enters for so large an amount, and the production of which shows a highly organized social condition, both in the ability to make them and in the demand for them. This process of specialization and diversity of employments, which in the early history of the country we have seen was of such slow growth, has here advanced with rapid strides.

Among the numerous manufacturing industries carried on in Cleveland, perhaps the most characteristic one of this kind is that of the Wilson Sewing-Machine Company. This company have within the short time since the sewing-machine was first introduced built up their business to its present proportions. Employing hun-

MANUFACTORY OF THE WILSON SEWING MACHINE CO., CLEVELAND, OHIO.

dreds of men in their works, they have a large force of agents scattered not only throughout this country, but also in Europe, engaged in creating and supplying the demand for their wares. To meet this demand, their works produce over sixteen hundred machines a week. Taking the inspiration for the character of their business from the spirit of Western industry, from the broad prairies which supply the world with cheap food, and the mighty rivers which carry to the sea the materials for the cheap food of nations, they designed to extend their business among the people by selling their wares so as to place them within the reach of all.

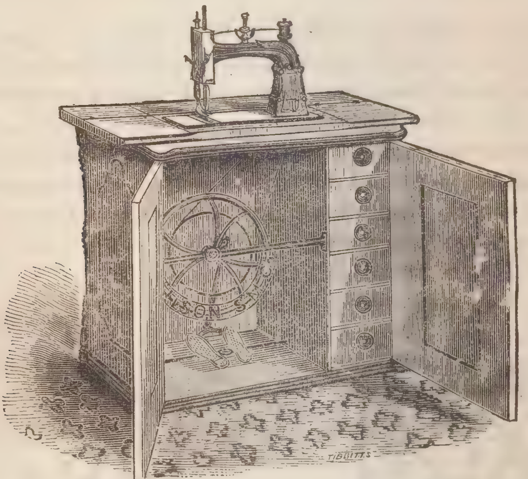
In the pursuance of this plan they have so organized their business as to be able to produce excellent machines of their class at a rate lower than the high-priced sewing-machines can be afforded; and while never allowing any machine of their make to be placed in the market which is not perfect in its operation, they have found their reward in the reputation their machines have gained among the consumers, and in the large demand for them which they have thus created.



Wilson Shuttle Sewing-Machine.

The gentlemanly inventor and proprietor of the Wilson machine is one of the remarkable products of free civilization indigenous to the West, and found nowhere else, whose destiny seems to ever be to lead on the march of empire in its westward growth, and himself, as well as his great factory, an object worthy of the tourist's visitation. Mr. Wilson is one of those advanced men who

give character to the enterprises they undertake, and always make their mark upon the times,—reaping usually the due reward of their genius and energy, commanding for themselves the luxuries as well as the honors of life. Mr. Wilson's superb "turn-out," as it rolls down Euclid Street, in Cleveland, is a marked feature in a democratic government, and not only an object of interest on account of the taste of the proprietor displayed in it, but as an historical contrast to the wagon of only fifty years ago, which moved over the same ground creaking on its axles, and now and then losing its linchpin.



Wilson Sewing-Machine. Full Cabinet.

STEEL.

THE STONE, BRONZE, AND IRON AGES. — THE STEEL AGE. — THE CHEMICAL CONSTITUTION OF STEEL. — THE EARLY PROCESS OF MAKING STEEL. — WOOTZ. — DAMASCUS BLADES. — RICHARD AND SALADIN. — MODERN ATTEMPTS TO IMITATE THE DAMASCUS BLADES. — GENERAL ANOSSOFF. — THE PROCESS OF CEMENTATION. — THE VARIETIES OF TEMPER. — DEFINITION OF STEEL. — TESTS OF STEEL. — MODERN PROCESSES OF MAKING STEEL. — THE BESSEMER PROCESS. — A DESCRIPTION OF IT. — PROFESSOR A. K. EATON'S PROCESSES. — PRACTICAL AND THEORETICAL PURSUITS. — THE IMPORTANCE OF THEIR UNION.

MODERN archæology divides the periods in the early history of the human race into the stone, the bronze, and the iron eras, thus indicating the gradual advance of mankind towards a methodic knowledge of the natural products of the earth, and an ability to make use of them for our own purposes. With his unassisted hands the primitive man had only such advantages over other animals as his different structure gave him, and in fact he was inferior to most of them in his ability to perform the operations for which they are fitted by nature with certain special appliances. The hog, for example, can turn up the ground in search of roots much better with his snout than a man can with his fingers.

From wood, bone, and finally from stone, the first tools were made; then entering on the metallic age, man first made use of such of the metals as are most readily found and most easily worked, until finally he became able to fashion iron for his use. Perhaps to the archæologist of the future, this age of the world's progress will be classed as the steel age, for we are certainly entering upon its application to purposes and uses for which it has not been before employed.

Chemically considered, steel occupies an intermediate position between wrought iron and cast iron; wrought iron being simply iron, while steel contains an addition of from one to one and a half per cent of carbon, and cast iron contains about four per cent of carbon. Steel may therefore be made by a process which shall give to wrought iron the necessary amount of carbon, or by another which shall eliminate from cast iron the excess of that substance. Of the

reason why this apparently slight change in chemical constitution should produce such marked changes in the properties of iron and steel, we know nothing as yet. The fibrous constitution of wrought iron appears by this process to become granular in texture, approximating cast iron in this respect, while it loses in ductility and malleability, but becomes elastic and harder, more difficult and slow to receive magnetic properties, but also more tenacious of them when received.

It occupies also an intermediate position between wrought iron and cast iron in its fusibility, melting at a much less degree of temperature than wrought iron requires, and only at a greater than required for fusing cast iron. The melting-point of steel is given as 2,786 degrees F.

The early process for making steel is most probably about identical with that still in use in India, and which has not varied since the time of Alexander the Great. It is supposed that the use of steel was known to the Egyptians, and that in their pictorial writings, as in the pictures decorating the tomb of Rameses III., the articles colored blue were intended to represent it. Butchers are here represented sharpening their knives upon what are supposed to be steel sharpeners. In Jeremiah xv. 12 occurs the sentence, "Shall iron break the northern iron, and the steel?" The term here is supposed to refer to the steel made in Chalybia, in Asia Minor, whose iron-works were so extensive as to give the name to iron among the Greeks, from whom we have now the term "chalybeate" as applied to mineral springs containing iron. Whether, however, the term "steel" is here correctly used to translate the original is questioned, and some authorities maintain that the correct translation is copper, the art of hardening which to a cutting edge we know was pursued by the ancients, though it is now lost.

Several expressions in Grecian authors are supposed to refer to steel. Homer compares the hissing made by the glowing stick which Ulysses thrust into the eye of the Cyclops to that made by a heated iron bar thrust by the smith into water. Yet no articles of steel have been found among the remains left us by the nations of antiquity, even down to the period of the Roman Empire.

The Hindoos still prepare steel in their early primitive way, which is uniformly practised from the Himalaya Mountains to Cape Comorin. Their name for it is *wootz*, by which it is known in commerce. The ore they use is a magnetic oxide of iron, mixed with quartz in the general proportion of forty-two parts of quartz to fifty-eight of

magnetic oxide. This is pounded fine, the quartz being separated from the oxide by winnowing. Their furnaces are small, and are built of clay, being four or five feet high, pear-shaped, measuring about two feet at the bottom and one at the top. The opening at the front is built up with clay for the smelting operation. The bellows used for intensifying the fire are made of a goatskin, stripped off whole. The holes for the legs are tied up, and a nozzle placed in the hole for the neck, while the air is supplied through the hole for the tail, which is closed when the air is blown out. With two such bellows, worked alternately, one by each hand, a continuous blast is kept up, of sufficient force to smelt the ore. The fuel used is charcoal. The iron thus made is converted into steel in crucibles, containing about a pound each. The iron is cut into small pieces, and mixed with wood chopped fine. Upon each crucible thus filled, one or two green leaves are laid. The proportions of iron and wood with which the crucibles are charged are generally ten of iron to one of wood and leaves. The crucibles are then plugged tightly with clay, and are piled up in an arch so as to form a furnace, which is charged with charcoal as fuel. The heat is kept up about two hours and a half. The crucibles are then allowed to cool, and on being taken out the steel is found in a cake in the bottom of each. If the fusion has been perfect, the tops of the cakes are covered with thread-like lines radiating from the centre. If, however, the tops of the cakes appear honeycombed, with lumps projecting, the fusion has been imperfect, and the cake is rejected. As an average, four or five of the cakes are found to be thus defective.

From the steel thus made, when remelted and drawn into rods, it is claimed by competent judges that the best cutlery can be made; and for this purpose that "it is infinitely superior to the best English cast steel." Not only is excellent steel made by this rude process among a people who, as yet, are guided in their operations by tradition only, having no conception of the more accurate methods of modern science, but depending entirely upon individual experience and skill for success; but the Hindoos, as do various other half-civilized nations, excel in tempering their weapons and tools, though this work is performed in the same rude manner. The celebrated Damascus blades, which were so highly valued in Europe for their temper and edge, were made in Damascus from this steel manufactured in India. The Crusades extended the reputation of these sword-blades all over Europe, and the readers of the Waverley Novels will recall the scene between Richard of England and Saladin, in which

they displayed the various merits of their respective weapons. Richard, with his long two-handed sword, severed at a blow the iron handle of a battle-axe, without injuring at all the edge of his weapon; while Saladin, to show the temper and sharpness of his Damascus blade, tossed a silken gauze scarf into the air, and, as it floated down, drew the edge of his scimitar across it, dividing it into two pieces without disturbing its slow movement.

The art of thus tempering blades has, however, been lost, and though numerous experiments were made in Europe to discover and imitate the process, they were unsuccessful. Though most probably the process was a simple one, yet it baffles all the science and skill of modern times. The nearest approach to success was made by General Anossoff, who conducted an extended series of researches with the most exact and scrupulous nicety. The success he met with led him to establish a manufactory at Zlatoosk, in the Ural Mountains, where he made blades similar to those of Damascus. His chief method of procedure was as follows.

The ore was melted with graphite, in crucibles charged with about eleven pounds each, together with a small quantity of dolomite. The fusion was continued as long as possible. The blast is kept up until all the fuel is consumed, and the crucible is not removed until it is cold. Attention is then to be given, in drawing the steel out, that it is not too hot. When tempered, the hardest finish is given at the straw-yellow color; the greatest elasticity at the blue; and at the green it begins to lose its elasticity. The blades are cooled by plunging in boiling grease. A sabre is given the best temper by a blue heat at the point, a violet in the middle, a yellow along the edge, and a green near the handle. At these works General Anossoff produced blades with which a floating gauze scarf could be divided at a stroke. They could be bent at right angles, and would return to their original form. Since the death of General Anossoff, in 1851, the quality of the products of the works has fallen off.

In Western Europe, during the Middle Ages, the manufacture of steel was almost unknown. In England, the first patent for making steel was given, in 1626, to Richard, Lord Dacre, Thomas Letsome, and Nicholas Page. The invention of the process was made by Letsome. In 1670, mention is made of the process of making steel by boiling the material "in sow-metal." This is supposed to be the method spoken of by various authors as in early use on the Continent.

The process of *cementation* consists of heating iron bars, packed in charcoal, in a furnace, for a period of from six to ten days, according to the quality or characteristics of the product required. The greater the heat maintained the quicker is the process of conversion. Steel thus made is called blistered steel, from the fact of the bars being found covered with blisters. Steel of this kind has its interior texture very irregular; it is white like frosted silver, and its fracture shows crystalline angles and facettes, which are larger in proportion as the process has been further carried on, and the mixture with the carbon of the charcoal has been greater. The crystals of the centre are always smaller than those near the surface of the bar. Before using for tools, such steel needs to be subjected to the process of *tilting*, as it is called; that is, it is drawn out by hammering, by which the texture is made more uniform and dense. Cast steel is blistered steel, broken into fragments, and fused.

The chief property, however, of steel, which gives it its value for so many purposes, is that of being hardened, or tempered. When exposed to a progressive heat, it takes in succession the following colors: 1, a faint yellow, which indicates the fit temper for lancets, which require the finest edge, with but little strength of metal; 2, a pale straw-color, indicating the temper for razors, and surgeons' amputating instruments; 3, a full yellow, indicating the temper for penknives, with increased toughness; 4, a brown yellow, indicating the temper for cold-chisels, and shears for cutting iron; 5, a brown with purple spots, indicating the temper for axes and plane irons; 6, a purple, indicating the temper for table-knives and shears for cloth; 7, bright blue, indicating a temper for swords and watch-springs; 8, a full blue, indicating a temper for small fine saws and daggers; 9, a dark blue, verging on black, indicating the temper for large saws, the teeth of which are to be sharpened with a file.

The degrees of heat required for these various degrees of temper are as follows: 1, 430° F.; 2, 450°; 3, 470°; 4, 490°; 5, 510°; 6, 530°; 7, 550°; 8, 560°; 9, 600°. Above this the metal approaches so near ignition that the differing colors cannot be distinguished. After ignition, if allowed to cool slowly, the steel becomes very soft, and fit for the use of engravers.

Steel has been defined as any kind of iron which, when heated to redness, and suddenly cooled by being plunged into cold water, becomes harder. Every kind of malleable or flexible iron which can be hardened by that process is a steel. A simple test to distinguish

steel from iron is found in dropping upon the surface of the body to be tested a drop of diluted nitric acid. This on steel gives a dark gray spot, while upon iron it gives a green spot. Steel, exposed to the air, rusts slower than iron; and the more highly it is carbonated the more slowly it rusts, and the darker is the spot made by the test with acid.

Tempering steel alters its texture, the granulation becomes coarser or finer according to the degree of heat to which it has been subjected. It can be made hard enough to scratch glass, and resist the keenest file, while it becomes very brittle. The quality of steel is tested by the homogeneous character of its granulation; by its being worked easily on the forge; by its hardening and tempering easily and well; by its strength of resistence; and by its elasticity. The first of these qualities is shown by grinding and polishing it, when the texture appears; the second test requires a skilled and experienced workman to heat it to the right degree; the color and size of the granulation are best shown by breaking a hardened and tempered bar, worked thin, in a razor-like form. Testing it with a file, or as a chisel for cutting iron, or subjecting it to heavy weights, will show the other qualities.

The difference between cast steel and bar steel is due simply to the mechanical effects produced by the hammering necessary in drawing it out. In order to produce this effect, blistered steel is broken into pieces, melted down, then tempered, broken again, and the pieces welded together at a good welding heat. By this process the steel is made more malleable, its texture more homogeneous, tenacious and uniform, and it will have these qualities in proportion to the number of times it has been subjected to this process. Steel so worked is called "wrought or shear steel."

If it is attempted to make steel, by cementation, from ordinary iron, in which the proportion of silica is generally quite small as compared with that of carbon, and in which, beside, there is not enough phosphorus and arsenic for softening easily the metallic molecules, the result will be only a carburet of iron and a little siliciuret of iron, and the carbon does not unite or combine with the silica. The steel will therefore be wanting in tenacity and malleability, since the molecules have not crystallized and united until they have taken up more carbon than enough to produce steel. Simple carburetted iron, or iron containing more carbon, will not harden at all when tempered. Sometimes even when it does not contain more carbon than steel of good quality it becomes friable and brittle when heated

to a red heat. The fracture of such steel will be gray and dull, while that of good steel is silvery, and shows cutical crystals.

The best steel is made by cementation from forged iron; and in the process the iron must not become completely fused, since then groups of crystals of different degrees of carbonization are formed. In making cast steel it is important that the workman should have the experience and skill sufficient to judge when the moment of proper fusion has arrived, since the quality and uniformity of the steel depends in a great measure upon this. The fracture of a bar of hard steel is silvery, and has a quantity of rays radiating from the centre, while that of softer steel is uniformly granular and crystalline in texture, and possesses all the brittleness of cast metals. Steel which is very hard and highly carbonized contracts considerably when fused and poured into moulds, so that great skill is needed to fill the moulds well. When steel is made from iron of bad quality, and carburets of various kinds have been produced in it during the process of cementation, melting it makes it worse, instead of better, since the carburets separate the more during cooling, and it is to these that the flaws and weaknesses of the steel thus made are due.

The fracture of cast steel should show a perfectly uniform and homogeneous appearance when the bar is broken by a sharp blow. The inequalities should be slight and undulating, blending at their bases insensibly with the rest of the metallic surface. When, on the other hand, they stand out perpendicularly, they show the separation at this point of two layers of unequally carbonized particles.

Numerous attempts have been made in modern times to discover some method for shortening and cheapening the process of making steel. A Mr. Josiah M. Heath patented, in 1839, the process of adding one per cent, or even less, of carburet of manganese to the melting-pot, with the blistered steel it was intended to cast. By this a better steel was produced, which had also the property of being weldable to wrought iron, or to itself. By this invention or discovery the price of table-knives in Sheffield, the seat in England of this branch of manufacture, was reduced from thirty to forty per cent. Beside this and other improvements in the method of manufacturing or working steel, the attention of inventors in modern times has been turned in another direction. Heretofore we have examined the methods in use for *carbonizing* iron; that is, for adding to iron the carbon by which it shall be converted into steel. But as steel holds an intermediate position as regards the amount of carbon

it contains, between iron and cast iron, we will now examine the attempts made to *decarbonize* cast iron, that is, to so reduce the amount of carbon it holds in combination as to convert it into steel.

It is only in quite modern times that this idea has been held by inventors, or that they could have proceeded methodically and scientifically to work to attain this end. It was absolutely necessary that chemistry should have arrived at the positive state of development which it has reached in quite modern times, before the knowledge or the ability to make an accurate chemical analysis could have existed, and it was only when such an analysis showed the chemical constitution of steel that men could have entertained the idea of arriving at the manufacture of steel by the process of decarbonization. There were several processes proposed for attaining this end, but we need notice here only the most successful one, known as the Bessemer process, from the name of its inventor, Mr. Henry Bessemer.

The method proposed in this process was to burn out the carbon, and to attain this result the iron in a state of fusion was to be supplied with currents of air, which should furnish the oxygen necessary for such combustion. The following quotation from a paper read by Mr. Bessemer himself before the Institution of Civil Engineers, concerning his process, will give, in the most condensed and authentic form, the desired information.

Mr. Bessemer says: "The want of success which attended some of the early experiments was erroneously attributed, by some persons, to the "burning" of metal, and by others to the absence of cinder and to the crystalline condition of cast metal. It is almost needless to say that neither of these causes assigned had anything to do with the failure of the process, in those cases where failure had occurred. Chemical investigation soon pointed out the real source of difficulty. It was found, that although the metal could be wholly decarbonized, and the silicium be removed, the quantity of sulphur and of phosphorus was but little affected; and as different samples were carefully analyzed, it was ascertained that red shortness was always produced by sulphur, when present to the extent of one tenth per cent, and that cold shortness resulted from the presence of a like quantity of phosphorus; it therefore became necessary to remove those substances. Steam and pure hydrogen gas were tried with more or less success in the removal of sulphur, and various fluxes, composed chiefly of silicates of the oxide of iron

and manganese, were brought in contact with the fluid metal during the process, and the quantity of phosphorus was thereby reduced. Thus, many months were consumed in laborious and expensive experiments; consecutive steps in advance were made, and many valuable facts were elicited. The successful working of some of the higher qualities of pig-iron caused a total change in the process. It was determined to import some of the best Swedish pig-iron, from which steel of excellent quality was made, and tried for almost all the uses for which steel of the highest class was employed. It was then decided to discontinue, for a time, all further experiments, and to erect steel-works at Sheffield for the express purpose of fully developing and working the new process commercially, and thus to remove the erroneous impressions so generally entertained in reference to the Bessemer process.

"In manufacturing tool steel of the highest quality, it was found preferable, for several reasons, to use the best Swedish pig-iron, and, when converted into steel by the Bessemer process, to pour the fluid steel into water, and afterwards to remelt the shotted metal in a crucible, as at present practised in making blister steel, whereby the small ingots required for this particular article were more perfectly and more readily made.

"The form of converting vessel which had been found most suitable somewhat resembled the glass retort used by chemists for distillation. It was mounted on axes, and was lined with 'gannister' or road-drift, which lasted during the conversion of thirty or forty charges of steel, and was then quickly and cheaply repaired, or renewed. The vessel was brought into an inclined position to receive the charge of crude iron, during which time the tuyères were above the surface of the metal. As soon as the whole charge was run in, the vessel was raised on its axis, so as to bring the tuyères below the level of the metal, when the process was at once brought into full activity, and twenty small though powerful jets of air sprang upward through the fluid mass; the air, expanding in volume, divided itself into globules, or burst violently upward, carrying with it a large quantity of the fluid metal, which again fell back into the boiling mass below. The oxygen of the air appeared, in this process, first to produce the combustion of the carbon contained in the iron, and at the same time to oxidize the silicium, producing silicic acid, which, uniting with the oxide of iron obtained by the combustion of a small quantity of metallic iron, thus produced a fluid silicate of the oxide of iron, or 'cinder,' which was retained in

the vessel and assisted in purifying the metal. The increase of temperature which the metal underwent, and which seemed so disproportionate to the quantity of carbon and iron consumed, was doubtless owing to the favorable circumstances under which combustion took place. There was no intercepting material to absorb the heat generated, and to prevent its being taken up by the metal; for heat was evolved at thousands of points, distributed throughout the fluid, and when the metal boiled, the whole mass rose far above its natural level, forming a sort of spongy froth, with an intensely vivid combustion going on in every one of its numberless, ever-changing cavities. Thus by the mere action of the blast a temperature was attained, in the largest masses of metal, in ten or twelve minutes, that whole days of exposure, in the most powerful furnace, would fail to produce.

"The amount of decarbonization of the metal was regulated with great accuracy, by a meter, which indicated on a dial the number of cubic feet of air that had passed through the metal; so that steel of any quality or temper could be obtained with the greatest certainty. As soon as the metal had reached the desired point (as indicated by the dial) the workmen moved the vessel so as to pour out the fluid, malleable iron, or steel, into a founders' ladle, which was attached to the arm of a hydraulic crane, so as to be brought readily over the moulds. The ladle was provided with a fire-clay plug at the bottom, the raising of which, by a suitable lever, allowed the fluid metal to descend in a clear, vertical stream into the moulds. When the first mould was filled, the plug-valve was depressed, and the metal was prevented from flowing until the casting-ladle was moved over the next mould, when the raising of the plug allowed this to be filled in a similar manner, and so on until all the moulds were filled.

"The casting of large masses of a perfectly homogeneous, malleable metal into any desired form rendered unnecessary the tedious, expensive, and uncertain operation of welding now employed whenever large masses were required. The extreme toughness and extensibility of the Bessemer iron was proved by the bending of cold bars of iron 3 inches square, under the hammer, into a close fold, without the smallest perceptible rupture of the metal at any part; the bar being extended on the outside of the bend from 12 inches to 16¾ inches, and being compressed on the inside from 12 inches to 7¼ inches, making a difference in length of 9½ inches between what, before bending, were the two parallel sides of a bar 3 inches

square. . . . . Steel bars, 2 inches square, and 2 feet 6 inches in length, were twisted cold into a spiral, the angles of which were about 45 degrees; and some round steel bars, 2 inches in diameter, were bent cold under the hammer into the form of an ordinary horseshoe magnet, the outside of the bend measuring 5 inches more than the inside.

"The steel and iron boiler plates, left without shearing, and with their ends bent over cold, afforded ample evidence of the extreme tenacity and toughness of the metal; while the clear, even surface of railway axles and pieces of malleable iron ordnance were examples of the perfect freedom from cracks, flaws, or hard veins, which forms so distinguishing a characteristic of the new metal. The tensile strength of this metal was not less remarkable, as the several samples of steel tested in the proving machine at Woolwich arsenal bore, according to the reports of Colonel Eardly Wilmot, R. A., a strain varying from 150,000 pounds to 160,900 pounds on the square inch, and four samples of iron boiler plate, from 68,314 pounds to 73,100 pounds; while, according to the published experiments of Mr. W. Fairbairn, Staffordshire plates bore a mean strain of 45,000 pounds, and Low Moor and Bowling plates a mean of 57,120 pounds, to the square inch. . . .

"That the process admitted of further improvement and of a vast extension beyond its present limits," the author had no doubt; but these steps in advance would, he imagined, "result chiefly from the experience gained in the daily commercial working of the process, and would most probably be the contributions of the many practical men who might be engaged in carrying on the manufacture of iron and steel by this system."

Beside these processes in use in other countries, for the purpose of making steel, either by carbonizing iron or decarbonizing cast iron, methods for producing the same result have been invented in America by Professor A. K. Eaton, which are now in successful operation. Having his attention directed to the necessity of cheapening the process of making steel, he found, in the course of experiments, that a bar of iron raised to a bright red heat in a tube, or in any other way protected, and subjected to the influence of cyanogen gas, a gas composed of carbon and nitrogen, was rapidly converted into steel. His application of this discovery was this: Bars of malleable iron, packed in charcoal, with which was mixed a proportion of yellow prussiate of potash, or any other cyanide, were under a high temperature carbonized into steel.

In the manufacturing of steel by this process, the iron, broken into pieces, and mixed with powdered charcoal and the cyanide salts, is heated in crucibles, thus producing cast steel. This process was patented, and has been extensively employed in various localities. The chief objection to it is the difficulty and expense of obtaining crucibles which can stand the needed heat. Continuing his experiments, and directing his attention towards the decarbonization of cast iron, Professor Eaton invented and patented, in 1861, various processes, of which the chief are the following. He found that by boiling iron castings, made from such iron as produces a silver-white iron, which is very hard, and so fluid when melted as to take the finest impressions from the mould, in fused carbonate of soda, the iron was gradually, from the outside, converted into steel, so that according to the stage of the process, which was tested by bars introduced into the pot, and removed from time to time, any desired grade of hardness, or any proportion of decarbonization could be given to the articles. The pots were made of cast iron, and it required a boiling of about twenty hours' duration to thoroughly decarbonize an article an inch in thickness. The carbonate of soda was found to be much better suited for this process than the hydrate.

He also discovered the use of carbonic acid gas as an agent for decarbonization. A retort, the bottom of which was covered with bits of limestone, was filled with pieces of cast iron, while through the top was an opening for the escape of the gas. The retort was so arranged as to be heated in the middle, furnishing only enough heat to the limestone to liberate the gas. The retort being heated, it was found that the gas escaping was inflammable, showing by its blue flame that it had become carbonic oxide, having acquired an atom of carbon from the iron. When the gas passing off was found to be no longer inflammable, the operation was known to be complete, and the retort being opened, the iron was found to have been converted into steel. The amount of carbonic acid needed to decarbonize any certain amount of cast iron is as 66 to 690, this last being the weight of the iron.

The addition of peroxide of iron increases the amount of gas produced, enabling the same amount to operate upon double the amount of cast iron. This process is known as the soda process, and some further modifications have been arrived at, by which the cheapness of the conversion has been increased, while the waste of the material has been lessened.

These various processes are in use in various places in the United

States. By the cheapening of the production of steel, and the ability to cast it in large masses which they have given to modern industry, it will be possible to so multiply and extend its uses that in the future steel will unquestionably replace iron, for many purposes, since its greater strength, its greater ability to resist atmospheric influences, and its elasticity, make it much more useful. Already we see in its application to railroad axles and rails but the beginning of the advantages to society at large which these inventions will produce. And here, even at the risk of being tedious, we cannot refrain from calling attention to the invention of these new processes as a further proof of the value and importance of scientific studies upon industrial pursuits; and also of the necessity that the theories of science should precede, as they must, the practical application of laws which are thus arrived at to the processes of industry.

It was impossible, before the theoretic pursuit of chemistry led to the deductions of the laws regulating chemical attractions, that men should arrive at the practical deductions by which they could institute experiments based upon a method, and confidently expect the certainty of success. Men who are engaged wholly in industrial or commercial pursuits are too apt to think lightly of the value of those who devote themselves to what is supposed to be mere theory, impracticable dreaming. On the other hand, those who, by the constitution of their minds, are naturally attracted to theory, are, in their turn, too apt to despise those who care only for what are termed practical pursuits. Here, however, as everywhere else, we see the necessity and the gain to both classes by a mutual esteem and sympathy, and a mutual union and co-operation, working towards the same end, the progress of mankind.

THE GATLING GUN.

THE ERA OF MACHINE GUNS. — THE IDEA AN AMERICAN ONE. — THE GATLING GUN THE PIONEER. — ITS HISTORY. — A DESCRIPTION OF ITS MECHANISM. — AN ACCOUNT OF HOW IT IS OPERATED. — THE PERSONAL HISTORY OF THE INVENTOR. — HIS OTHER INVENTIONS. — THE TRANSMISSION OF POWER BY COMPRESSED AIR. — ITS USE IN EUROPE AND THIS COUNTRY. — ITS FUTURE. — THE GATLING GUN.

WITHIN the past few years attention has been turned towards the invention of machine guns; and in the recent wars which have raged in Europe their use by the French has brought them forcibly to the consideration of European nations. There can be, however, no doubt that the idea of a machine gun is entirely American, and that the Gatling gun was the original from which were derived the *mitrailleuse* and the other machine guns.

This fact will appear from a simple history of the invention of the Gatling gun. The first gun of this kind was built by the inventor, R. J. Gatling, M. D., in 1862, in Indianapolis, Ind., his place of residence, and his first American patent bears date of November 4, of that year. The idea of the gun had occurred to Dr. Gatling in 1861, and he had within this short time reduced his conception to this practical realization. This gun was repeatedly fired during 1862, in the presence of thousands of persons, discharging two hundred shots a minute, and the results of the trials were published to the world.

In the autumn of 1862 Dr. Gatling went to Cincinnati, and had six of his guns constructed in the establishment of Miles Greenwood & Co.; but about the time they were completed the works were destroyed by fire, and the guns, together with the patterns and drawings, were consumed. Soon after this accident, however, Dr. Gatling made an arrangement with another firm in the same city, and twelve of these guns were made. During this time the gun made at Indianapolis was repeatedly fired in Cincin-

nati before officers of the army; and the press of the United States, during the years 1862 and 1863, spoke frequently of the trials and their results, while no mention had as yet appeared of any such invention as a machine gun in Europe.

There was no effort made to keep the facts of the Gatling gun secret; on the contrary, it was evidently the desire, as it was the interest, of the inventor that as wide a publicity as possible should be given to it, and to the success which had attended its trials. Full descriptions of the gun were also published, with cuts and diagrams showing the method of its working, and these were sent to all parts of the civilized world. During 1863 and 1864 Dr. Gatling continued to make these guns in Cincinnati, and in the fall of this last-mentioned year made improvements in the lock and rear cam, without, however, altering its main features. These improvements were secured by a patent, which bears date May 9, 1865.

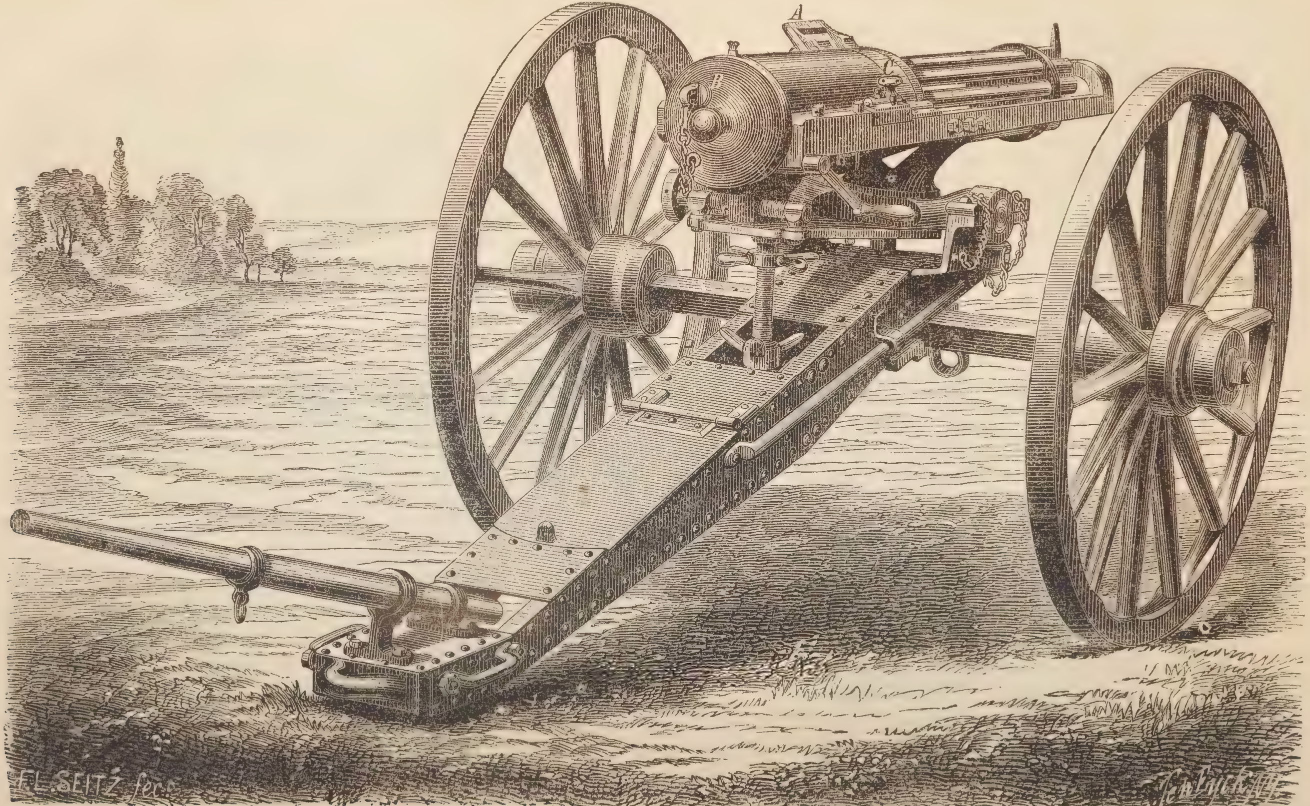
During the year 1865 and 1866, the guns thus improved were manufactured in Philadelphia at the Cooper's Fire-arms Manufactory, and since that time have been made in large numbers at Colt's Armory, in the city of Hartford, Conn., where expensive machinery has been fitted up to make them in the highest perfection. The accuracy of the dates in this statement is placed beyond denial by the official report to Governor Morton, of Indiana, of a committee appointed to examine the merits of the gun. This report is dated Indianapolis, July 14, 1862, and signed by T. A. Morris, A. Ballweg, and D. G. Rose. A gun made in 1862, and having this date upon it, can also be found in the Ordnance Museum at Washington. The report to Governor Morton so impressed him with the value and efficiency of this gun, that, in 1862, he wrote officially to the Assistant Secretary of War, at Washington, P. H. Watson, Esq., to call his attention to the subject of introducing it into the national service. In 1863, during the months of May and July, trials of the gun were made at the Washington Navy Yard, and its merits favorably reported upon by Lieutenant J. S. Skerrett, of the army.

From among the mass of testimony, official and otherwise, which could be brought to establish the claim of the Gatling gun to being the first practically efficient machine gun made, the above instances must suffice, since our space will be better occupied with a statement of its method of construction. The gun consists of a series of barrels, in combination with a grooved carrier and lock-

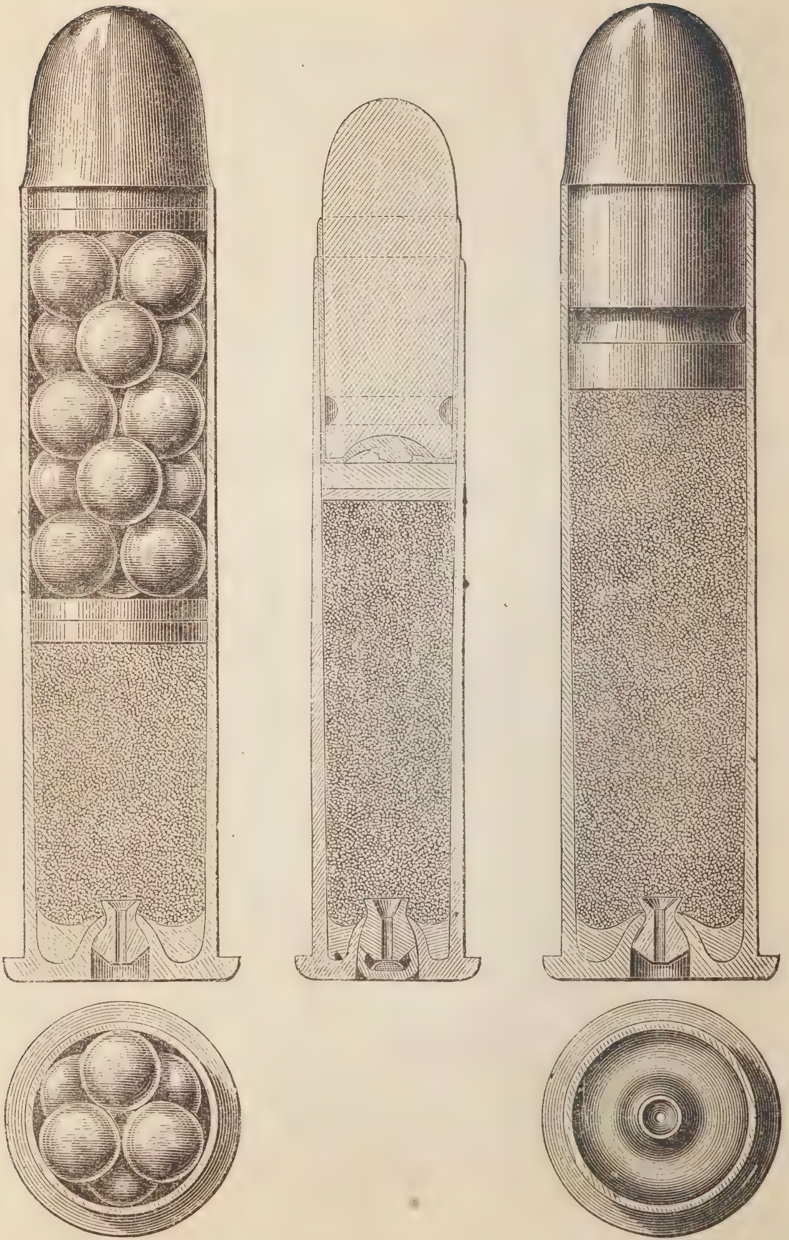
cylinder. All these several parts are rigidly secured upon a main shaft. There are as many grooves in the carrier and as many holes in the lock-cylinder as there are barrels. The lock-cylinder, which contains the locks, is surrounded by a casing which is fastened to a frame, to which trunnions are attached. There is a partition in the casing, through which there is an opening, and into which the main shaft, which carries the lock-cylinder and barrels, is journaled. The main shaft is also at its front end journaled in the front part of the frame. In front of the partition, in the casing, is placed a cam, provided with spiral surfaces or inclined planes. This cam is rigidly fastened to the casing, and is used to impart a reciprocating motion to the locks when the gun is rotated. There is also in the front part of the casing a cocking-ring, which surrounds the lock-cylinder, is attached to the casing, and has on its rear surface an inclined plane, with an abrupt shoulder. This ring and its projection are used for cocking and firing the gun. This ring, the spiral cam, and the locks make up the loading and firing mechanism.

On the rear end of the main shaft, in the rear of the partition in the casing, is located a gear-wheel, which works to a pinion on the crank-shaft. The rear of the casing is closed by the cascable plate. There is hinged to the frame, in front of the breech-casing, a curved plate, covering partially the grooved carrier, into which is formed a hopper or opening, through which the cartridges are fed to the gun from feed-cases. The frame which supports the gun is mounted upon the carriage used for the transportation of the gun.

The operation of the gun is very simple. One man places a feed-case filled with cartridges into the hopper; another man turns the crank, which, by the agency of the gearing, revolves the main shaft, carrying with it the lock-cylinder, carrier, barrels, and locks. As the gun is rotated, the cartridges, one by one, drop into the grooves of the carrier from the feed-cases, and instantly the lock, by its impingement on the spiral cam surfaces, moves forward to load the cartridge; and when the butt end of the lock gets on the highest projection of the cam, the charge is fired, through the agency of the cocking device, which at this point liberates the lock, spring, and hammer, and explodes the cartridge. As soon as the charge is fired, the lock, as the gun is revolved, is drawn back by the agency of the spiral surface in the cam acting on a lug of the lock, bringing with it the shell of the cartridge after it has been fired, and dropping it on the ground. Thus, as



THE GATLING GUN.



CARTRIDGES USED IN THE GATLING GUN.

the gun is rotated, the locks, in rapid succession, move forward to load and fire, and return to extract the cartridge-shells. The whole operation of loading, closing the breech, discharging, and expelling the empty cartridge-shells is conducted while the barrels are kept in continuous motion. The gun is so novel in its method of operation that it is almost impossible to give a satisfactory account of it without detailed illustrations, for which we have not the space.

One feature should be specially noticed — that while the gun is revolving with a constant and uniform motion, the locks rotate with the barrels and breech, and at the same time have a longitudinal, reciprocating motion, performing the consecutive operations of loading, cocking, and firing without any pause in these consecutive operations. There is no other gun in existence in which the barrels, inner breech, and locks all revolve simultaneously. This gun can neither be loaded nor fired except when the barrels, locks, and breech are revolving. This gun has been accepted by most of the European governments, and numerous ones have been made for Russia at Hartford, Conn., also at Vienna, Austria, to fill the orders of Hungary and Turkey, and of England at Newcastle-upon-Tyne.*

The inventor, Richard Jordan Gatling, was born in Hartford County, N. C., the 12th of September, 1818. His father was a substantial farmer, and the young inventor obtained such advantages of education as the common schools of that region afforded. From his father, however, who was a man of great energy of character, he received, though living in a slaveholding community, the lessons of the necessity of labor and economy as the surest roads to success. When but a lad, he assisted his father in the invention of a machine for sowing cotton, and another for thinning out the young cotton plants, which, with modifications, are still in use in the South.

His youth was passed in a variety of employments — teaching school, serving as a clerk, and in doing business on his own account. He also invented the propeller-wheel, in the form in which it is now used; but on going to Washington with his model, in order to apply for a patent, he found that he had been forestalled in his invention. The disappointment and mortification of this failure were

* Improved Gatling guns can now be fired at the rate of four hundred shots per minute.

severe, because he foresaw the importance of the new method for propulsion ; but with youth and energy, he overcame its depressing effects. In 1844 he patented a machine for sowing rice, and, having removed to St. Louis, adapted it to sowing wheat, and introduced this first machine of the kind to the farmers of the West. While on a trip from Cincinnati to Pittsburg, he was attacked by the small pox ; and having his attention thus turned to the advantages of a knowledge of medicine, he went through a course of medical study, not with any purpose of practising the profession, but to satisfy his own desire for knowledge.

In 1849 Dr. Gatling invented a method of transmitting power by means of compressed air driven through pipes. His application for a patent for this process from the United States was rejected by the commissioner on the ground that it was a discovery, and not an invention. Patents were, however, obtained for it in Europe ; and it is by means of this method that the tunnel of Mont Cenis has been worked. The process is also, we believe, used in the work on the Hoosac Mountain Tunnel. The refusal to grant him a patent called his attention from this valuable idea, though it is unquestionable that by it, in the future, power will be thus created and distributed in cities, avoiding the bother, expense, and complication of individuals having their own sources of power. Like the distribution of gas and water, this method of distributing power is at a glance so advantageous that its merits are evident.

In 1857 Dr. Gatling invented and patented a steam plough, or earth-pulverizing machine, to be propelled by steam and animal power combined. The failure of his health, and the low price of grain at that time, prevented his bringing this invention into practical use. Since 1861 Dr. Gatling, as has been stated, has devoted his time and attention to the gun which bears his name ; and the success which has attended his labors has temporarily seduced him from the more congenial field of peaceful invention.

THE MANUFACTURE OF CHEESE.

THE ORIGIN OF OUR PRESENT CHEESE-FACTORIES. — THE EXTENSION OF THE SYSTEM. — THE DAIRYMEN'S ASSOCIATION. — THE EXTENT OF THE BUSINESS OF CHEESE-MAKING. — THE PROCESS OF MANUFACTURE. — THE PROFITS OF THE BUSINESS. — THE EXPENSES. — THE POSSIBLE FUTURE IMPROVEMENTS.

About twenty years ago a substantial farmer in Oneida County, Central New York, had won an enviable reputation among his neighbors for the uniform excellence of his cheese. One of his sons bought a farm, a few miles distant from his father's, and proposed to lift the debt upon it by cheese-making. But he could not be sure of as good prices as his father's make always commanded. It was therefore arranged, between father and son, that the milk from the new farm should be brought over in cans and made up in the paternal cheese-room. The plan worked admirably, and the next year some of the neighbors asked to be admitted as partners or patrons. It was done, and presently other dairymen followed the example set by the Williams family, and a dozen or more cheese-factories were erected.

In the years 1862 and 1863 the system spread rapidly, on account of excellent prices obtained in England for American cheese. A year or two later, the farmers who make cheese a special product formed an association, and sent their most intelligent members to England to study English methods and the London market. The society thus begun grew apace, and was enlarged to the American Dairymen's Association, which holds annual conventions at Utica, and publishes a volume of reports each winter, in which the various problems and difficulties of cheese-makers are fully and ably discussed. The fame of these meetings, and the reading of this literature, has stimulated other communities, and the cheese-factory system, or the American system, as English dairymen call it, has spread through the Western States, has penetrated to Kentucky and North Carolina, and is pushing rapidly across the great grassy

plains which spread from the Missouri River to the base of the Rocky Mountains.

The result is remarkable uniformity in the size, flavor, and general excellence of our cheese and its consequent popularity in the English markets. Cheese-making has thus, within eight years, come to the front as a great rural industry, in which many millions of capital are invested, and several hundred thousand men and women find wholesome, regular, and well-rewarded employment.

The essential equipments of a cheese-factory are from one to six large vats, holding a thousand or twelve hundred gallons. These vats rest upon or fit into a tank, or water-tight box, and there must be some arrangement for heating that water to blood-heat. There are eight or ten, sometimes twenty presses; some simple tools for handling and working curds; and in the story above the cheese-making room, or in a separate but adjacent building, a large apartment with conveniences for keeping the temperature at or near seventy degrees Fahrenheit. Here the cheeses are cured or ripened. A platform-scale is required for ascertaining the pounds of milk brought by each patron daily. A few factories buy the milk of the farmers, paying them about two or two and a half cents a quart. But in most cases the cheese-maker is allowed so many cents per pound for manufacturing the milk into cheese and making sale of it. We will suppose that several hundred gallons per day have been engaged, and the factory gives notice that they will commence to make on the 10th of May. Each patron is provided with one or more large tin cans holding say forty gallons; by sunrise these cans begin to arrive, and most or all of them are in by seven o'clock. There is a platform about four feet high, close beside which the wagons are driven, and the cans are lifted or rolled at once from the wagon to the scale, and the contents noted. The careful cheese-maker also observes the condition of the milk, testing it by smell and tongue, and, if he does not approve, setting some in a jar by itself, and perhaps refusing to pour the contents of a suspected can into his vat. By a steam-pipe running through the water under the can, the milk is slowly raised to about eighty or eighty-five degrees, when the rennet is added. This is a liquid obtained by soaking the dried stomach of a young calf in tepid water. The peculiar acid of the stomach whose function is to convert milk into curd acts with great promptness and power, and a little of this gastric or peptic acid will affect a great body of milk. But it is important that the rennet should be wiped very clean and carefully dried, without the

use of much salt. Bad rennet imparts its qualities to the curd, and lowers the flavor, and especially the curing and keeping qualities of the cheese.

In a little while the rennet, by gentle stirring, has affected the entire body of cheese in the vat and the whole is curdled. Soon the whey parts from the curd, and this is promoted by running a blunt-edged wooden sword or series of cutters through the body of the curd. Now a part of the whey is drawn or dipped off, and the heat is raised under what remains, in order to scald it. The degree of heat to which the curd is subjected is a matter in debate among the members of the craft. In our hottest months many believe it necessary to make a very stiff curd and raise the heat to nearly 100°. But tenderness and the fine, even, pasty quality that is most admired in good cheese, cannot be obtained if the curd is stiffened by whey over 80° or 85° in temperature. The peculiarity of the Cheddar, the best English make, is, that the curd is handled with great care and never scalded hard. High heat also melts a portion of the cream and drives it away in the whey, thus reducing the quality of the make and requiring more milk for a pound of the product. As a rule, ten pounds of milk go to a pound of cheese; but care and skill in making produce noteworthy differences in this respect. In some factories nine pounds of milk represent a pound of cheese; in a few, eight and three quarter pounds of milk only are consumed in giving the pound of cheese; while in badly conducted dairies eleven pounds of milk disappear for every pound of salable product. About the time of the scalding, the lumps or cubes of curd, as they are cut by the curd-knife, are made considerably smaller by being ground between the fingers of the operator, or by the use of curd mills. The best operators are careful, at this stage of the process, to press the curd as little as possible. When the curd is fine enough and firm enough it is lifted from the vat and laid upon a strainer of strong, coarse linen, where most of the whey drips away from it. Now it is salted and thrown into the hoops, which are generally of galvanized iron strongly bound, and the hoops are fitted with a follower like a rude piston-head and a weight, at first very moderately applied. Much may be known of the skill of the cheese-maker by noting the color of the whey. It should be of a pale green color, and watery in appearance. If it flows thick and milky in color, caseine and butter are driven off and the operation is badly conducted in some respects. The size of most of the factory cheese is from fifty to sixty pounds. We have supplied ourselves with hoops

and presses for making this large cheese, because this size suits the English market. In order to please the same customers, we have adopted the practice of staining our curds a deep yellow with an extract of the anotta bean. When a cheese is pressed, that is, when no more whey runs from it, it is taken into the curing room, where it is kept at about 70° for six weeks or two months. Here it is turned every day, and the rind rubbed over with fresh whey-butter made of a deep yellow color with anotta. As soon as the curd of each day has been handled, the vats are carefully washed and scalded out, the floors also scrubbed, and the factory put in readiness to receive the evening's milking. In hot weather, this is poured into the vats, and a stream of cold water is poured through the vessels under the tanks to reduce the temperature certainly as low as 70°, and to 62° if practicable.

Much vigilance is required, during the months of July and August, to prevent mischief to the entire vat of milk, on account of the misbehavior of one or two dairies. If cows are worried by dogs, if they drink bad swamp water, if they wade in black muck and are annoyed by mosquitoes, if carrion pollutes the air of their pastures, if they are fevered by sexual heat or abused by harsh attendants, if the grasses they eat are coarse and watery, all these circumstances report themselves in the imperfect quality of the milk, and, during the hottest months, many factories are greatly annoyed and nonplussed by the bad behavior of their curds. The vats emit an unpleasant odor, — there is a gas that becomes entangled in the curds and causes them to float on the whey, instead of slowly settling beneath it, as all good curd will do. If this impure curd is made into cheese, it will swell on the shelves, and crack or discharge whey, and give the maker great annoyance.

There are, in the State of New York, something near 900 cheese-factories. Each of these represents, on an average, 475 cows. In cows whose milk is used mainly in cheese-making, this State has twenty million dollars invested, and the money employed in her 900 cheese-factories cannot be less than three millions. The annual receipts from each cow are in some factories $ 70 in some $ 60, but the average may not reach above $ 50. The cheese of New York is mostly shipped to the city. The number of cheeses annually received in New York City ranges from a million to a million and a half boxes, and the average weight of each cheese is about fifty pounds. The wages of a cheese-maker, in a factory where the milk of several hundred cows is handled, are good. A man with a good reputation

readily commands \$ 50 and \$ 60 a month. He needs one male and two or three female assistants, who are paid from \$ 12 to \$ 20 a month.

The cost of the building, in which, for instance, the milk of one thousand cows can be received, is generally from \$ 2,000 to \$ 3,000, though a much more durable and cooler building, with heavy stone walls, and stone or concrete floors, costing \$ 4,000, would be much better suited to the production of first-class cheese.

In some factories butter as well as cheese is produced. Sometimes the milk brought at night is skimmed before the morning's arrival is added to the vats. Cheese where a part only of the cream from half the milk is removed is about as good, if all the subsequent manipulations are proper, as that where all the cream is stirred in, and little or no difference in the price is noticed. In other establishments the milk is poured into pails which are set in a tank of cool water, or by some arrangement kept at a temperature of about 60°. When most of the cream has come to the surface and been removed, the milk is treated with rennet in the usual way, and skim-milk cheese is the product. It is about as nutritious as richer cheese, but low in flavor and less easy of digestion. Still, when good prices are obtained for the butter thus made, the whole income from a creamery, counting sales of butter and cheese, is greater than when cheese alone is sold.

The business in America has, however, just begun; and the markets for which our cheese is made are our own and that of England, where the least fastidiousness of taste is exercised, and, in consequence, the finer varieties of cheese are unknown and unappreciated. In Paris, however, there are some thirty varieties of cheese, varying from the delicate *double crême suisse* which is of a consistency only a little thicker than cream, and of as exquisite a flavor as though perfumed with the pollen of flowers, to a cheese as strong as may be desired, each of them having its own distinctive flavor, and each of them made with such accuracy that from year in to year out they are the same, there being no hazard or chance in the result. With a larger experience and a greater cultivation of taste among the consumers, unquestionably, in time, the business of cheese-making in America will attain a perfection which may compare favorably with that of any country; for here are the elements of a greater diversity of culture than in any other land where the political relations do not allow the freedom we enjoy for development.

CHILLED ROLLS AND ROLLING MACHINERY.

THE INCREASED WORKING OF METALS IN MODERN TIMES. — THE INTRODUCTION OF THE ROLLING MILL. — ITS EFFECT UPON METAL-WORKING. — THE MANUFACTURE OF ROLLING MACHINERY. — THE FARREL FOUNDRY AND MACHINE COMPANY: — THE PROCESS OF MAKING CHILLED ROLLS. — THE CONSTRUCTION OF THE MOULDS. — CASTING THE ROLLS. — FINISHING THE ROLLS. — ROUGHING MILLS. — FINISHING ROLLS. — GRINDING THE ROLLS. — THE PROCESS BY WHICH ACCURACY IS SECURED. — HISTORY OF THE ESTABLISHMENT OF THE FARREL FOUNDRY. — ITS PROBABLE FUTURE.

The wonderful increase in the working of metals, which is so distinguishing a characteristic of the industry of this country during this century, is chiefly due to the ability of handling them which has been brought about by the use of the rolling mill. Though this method of working metals has been known and practised only a little over two hundred years, yet in that time it has revolutionized the entire treatment of metals; and though there are now some hundreds of rolling mills scattered throughout the country, yet in the future the business appears destined to greatly increase, and the uses of the metals in the arts to receive an extension which shall be as great, if not greater, than that which has taken place during the last century.

To the successful introduction of the rolling mill we owe the ability to manipulate iron so that bars, sheets, and rails can be produced readily and cheaply; and, in fact, it is upon this invention that iron vessels, railroads, and steam boilers have become possible, together with many other applications of iron to various purposes of a similar nature. With the great increase of the rolling mills, the preparation of their machinery has become an important interest, and the manufacture of chilled rolls, which are the rollers for rolling mills, is of itself a very considerable business. The chief establishment in the country, engaged in this branch of industry, is the Farrel Foundry and Machine Company, at Ansonia,

Conn. The iron used in making chilled rolls is pig iron and cannon iron, and of these only the best quality is used.

The process of casting chilled rolls is as follows: The molten iron is run from the furnace into cast-iron moulds, which are slightly heated before the iron is run into them, in order to keep them from cracking or splitting from the heat of the fused iron. The cast-iron mould draws the heat from the casting rapidly, and thus chills the face of it; whereas, if the casting was made in sand, as is generally done, the iron would be a long time in cooling. The effect of this speedy cooling or chilling is to greatly harden the surface of the roll, and make it much more suitable for the purpose for which it is intended. Only the "body" of the rolls, that is, the part which is actually to become such, or the surface extending in towards the centre a few inches, becomes chilled and hard enough to serve as a roller for copper, brass, and other metals. The journals of the rolls are cast in the sand at the same time with the rolls, the sand-mould being made for it below the cast-iron mould for the roll. A deep pit is sunk in the floor of the foundry, and at the bottom is placed an iron flask, or a series of flasks, set one upon another, in case a long journal is required. The journal is the axis upon which the roll revolves in the rolling mill. This flask contains a sand-mould, in which the journal part of the roll is to be cast. Upon this the "chill," or cast-iron mould, is placed. The chill is a hollow cast-iron cylinder, which may be from four to seven inches thick, and from four to twenty-four inches in diameter, according to the size of the roll it is intended to make. The chill is made in sections, or consists of several hollow cylinders placed one above the other, and locked together, if they are small; but if they are large enough to remain in place by their own weight, they are simply superposed, without being locked together.

After the chill is in position, it is surmounted by an iron flask containing a sand-mould similar to the one at the bottom, in which the journal for the upper end of the roll is to be cast. The bottom flask is provided with a "pocket," or a projection from its circumference, extending about a foot, into which the iron is poured through a "runner," which is a long cast-iron flask, containing a hollow sand-mould or tube, and which reaches to the top of the pit. Into this runner the molten iron is poured, and the casting may be said to begin at the bottom and continue upwards. The object of casting the roll in this perpendicular position is to obtain

greater certainty that the surface of the roller will be without any flaw, solid, and having no pores or bubbles in it. The specific gravity of the molten iron, as it rises in the mould, forces above it whatever air may be in the mould at the bottom, and carries with it, floating upon its top, all the dirt there may be in the mould. This dirt, which gathers at the top, is called the "riser," and is cut off, being spongy and full of air-bubbles.

The sand-moulds, when they are formed, are blacked with charcoal blacking — a combination made of pulverized charcoal and clay water. The moulds are then placed in a furnace, and baked until they become as hard as a brick. Then they are ready to be placed in position for the casting of the roll. In casting the roll, the molten iron, as it rises in the cast-iron roll, is chilled by its contact with the cast iron, and by this process some difference takes place in the atomic arrangement of its particles, by which it becomes hard, and fit to endure the severe usage and immense pressure to which it will be subjected in the rolling mill. After the rolls are cast, they contract sufficiently upon cooling to be easily lifted from the mould, and are then taken to an engine lathe, where the journals are turned. When this is done, they are removed to large facing-lathes, in which the chilled cylinder is faced off, or turned to great smoothness of surface, and to the size required. The process of turning the chilled face of the roll is very slow on account of its great hardness. A roll of medium size, say sixteen inches in diameter and thirty-six inches long, requires about three days to be properly turned.

After they are turned, the rolls are removed to a grinding-lathe, and the journals ground upon emery wheels until they are perfectly smooth. This process takes about two hours. Then they are carried to emery grinders of a finer quality, where the chilled portion is ground for about the space of five hours, when the roll is finished. So accurate and true are these rolls made, that iron and other metals have been rolled out by them into sheets as thin as paper. A hundred weight of iron has been made into a sheet thin enough to cover seven thousand and forty square feet, indicating thus a thickness of two hundred and fifty leaves to an inch. At an industrial exhibition in Breslau, in 1852, a bookbinder exhibited a book bound by himself from sheets of iron thus prepared, and the leaves of which were as flexible as paper, and quite competent to be printed upon.

The roughing rolls, in quite common use in the United States for

the purpose of rolling the bloom from the furnace into bars, is so constructed as to leave between the rollers, which revolve close together, one above the other, lozenge-shaped openings, through which, as the bloom is drawn, it is elongated, while at the same time the edges are kept even, and the bloom is in good shape for making round, flat, or square bars. To reduce bars from six inches to one inch square, they should be passed, if of hard iron, through nine grooves of gradually diminishing sizes ; if the iron is soft, six grooves will answer. The diameter of a roughing roll is from eighteen to twenty inches. Different forms are given to the rolls, according to the various shaped bars to be made ; some of them are quite complicated, and require much ingenious skill in their construction, as, for instance, in those which are used for making the rails for railroads.

Finishing rolls are often arranged in what is called a "train." Sometimes these consist of three rolls placed together, one above another, by which the operation is much expedited, the bar being rolled as it passes each way, first below and then above the middle roll. Sheet iron is passed, under great pressure, through hard and well-polished rolls, which are kept at a low temperature, and often reheated. For this purpose it is essential that both the iron and the fire should be entirely free from sulphur. Charcoal is the best fuel, and superior qualities of gray pig iron make the best sheets. To make the surface of the sheets clean, as they pass into the rolls a scraper is so arranged as to scrape away all the scales which would injure the polish and color of the sheets. Sheets of iron, which are intended for tinning, are passed through the rolls cold. Boiler-plate iron is rolled at one heat from a slab forged under the hammer, twelve to eighteen inches long, seven to ten wide, and two to three thick, heated to a bright red, but not a welding heat. As it is rolled, the iron is repeatedly sprinkled with water, which chills the surface, causing the scale to fall off. This must not be done, however, with the finer qualities of sheet iron, and in making these the use of water is carefully avoided.

At the Farrel Foundry and Machine Company's establishment all kinds of rolling mills are made, for rolling iron, brass, copper, tin, German silver, gold leaf, britannia metal, tin foil, and pasteboard or paper, such as the rollers used by photographers for rolling their cards. These rolling mills for various purposes are constructed upon the same general mechanical principles, and differ from each other chiefly in sizes, and in their special adaptation to

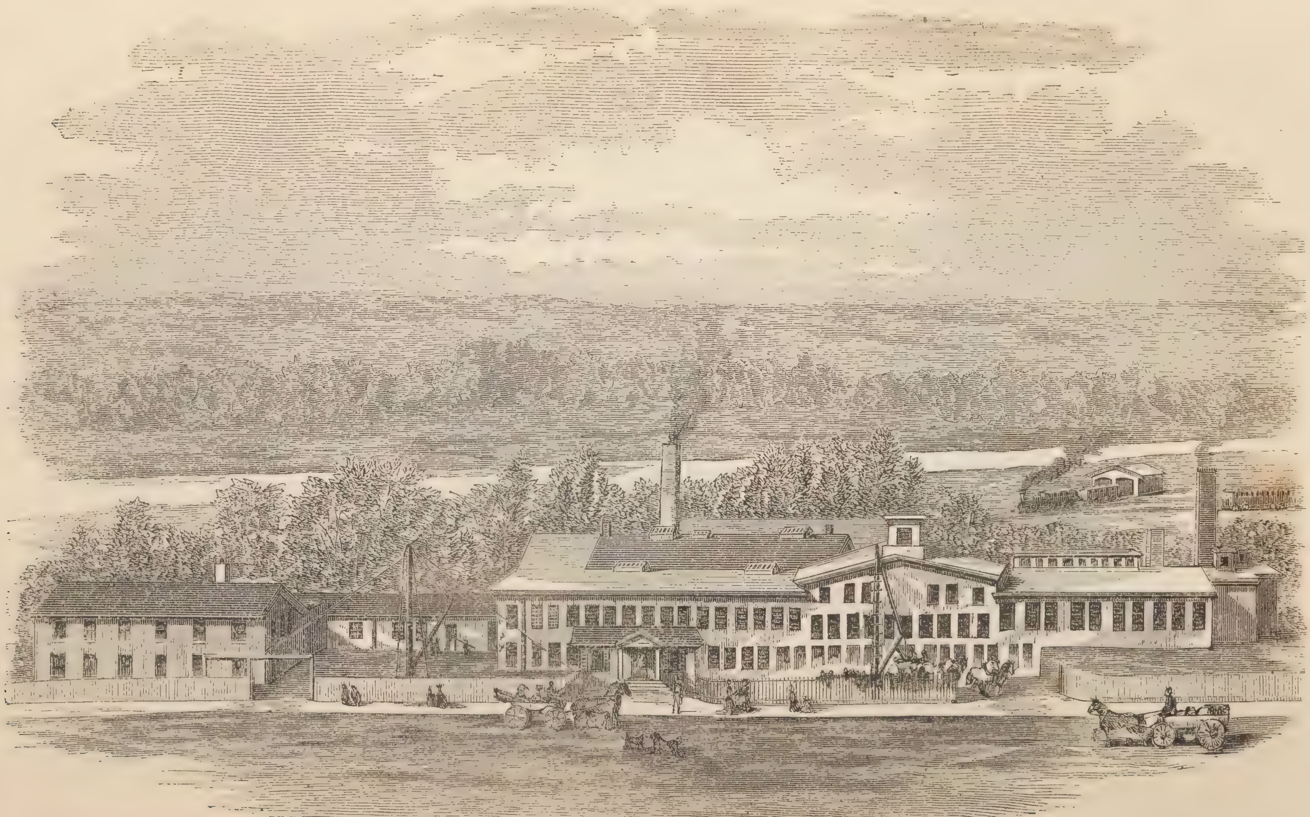
certain specific ends. In their construction mechanical skill is required, and in some of them this must be of a very high order, and united with a scientific ability to thoroughly comprehend and master the difficulties in the way of their successful working.

Besides rolling mills of all descriptions, machinery of other kinds is made at the works of the Farrel Foundry and Machine Company, such as machines for working rubber, calenders and grinders, calenders for paper, in which great care is necessary in order to secure the required accuracy in the working of the machine.

The process used in this establishment for grinding the rolls is peculiar to it, being patented and controlled by the Farrel Foundry and Machine Company. By the use of this process of grinding the rolls at this establishment, the rolls are perfectly adjusted to each other, that is, each roll is perfectly cylindrical throughout its entire length, its surface, considered in its length, being made up of an infinite number of minute lines, which are all exactly parallel to each other. Such certainty of accuracy can be secured by no other process of grinding. Two emery wheels are used in the process of grinding, one on each side of the roll, and placed exactly opposite each other. These are then caused to move at the desired rate of motion along the roll, the surface of which is kept cool by a constant stream of water. The emery used in this operation is of about that grade known as No. 90.

At the Farrel Foundry and Machine Company more chilled rolls are made than at any other establishment in the United States. For burring off the face of the chill two tools are used at the same time, making together a cut about fourteen inches in width. The chief portion of the establishment is situated at Ansonia, upon the the banks of the Naugatuck River, and the power used is both water power and steam. At Waterbury is also another portion of the establishment, at which a great many of the presses manufactured by the Farrel Foundry and Machine Company are made, this part of their production being a specialty with this portion of their works. In the manufacture of chilled rolls only the very best quality of iron is used, the differences in iron in this respect being very great. Some iron will chill for the distance of six or seven inches, while other qualities will not chill at all.

The Farrel Foundry and Machine Company was founded in 1848 by Almon Farrel, the father of Franklin Farrel, the present president of the company. After the death of Mr. Almon Farrel,



WORKS OF THE FARRELL FOUNDRY AND MACHINE COMPANY, ANSONIA, CONN.

which occurred in 1857, the management of its affairs passed into the hands of Mr. Franklin Farrel, who has retained this position ever since. The capital stock of the company was originally fixed at ninety thousand dollars, but has since been, practically, largely increased, until, as in the case of many other of the successful establishments of New England, the "nominal capital," so called, bears but little comparison to the actual capital employed; and under the energetic management of its president, the concern has largely increased its facilities for the transaction of its business, which is now the largest in its specialty in the United States, and which is still increasing.

With the great increase of our industrial activity, and the growing population of the country, the uses of metals in this era of civilization must keep pace, and new applications for them be continually discovered. With this the appliances for working them, chief among which is the rolling mill, will come into greater demand, and the future production of the Farrel Foundry and Machine Company, great as it is at present, may be depended upon, under the management which has brought it to its present importance, to keep pace with the demand, until it shall hold, in comparison with the manufactories of the world, the same leading position which it now holds with reference to those in the United States.

COTTON MANUFACTURES.

INTRODUCTORY HISTORICAL COMMENTS. — COTTON FABRICS IN EGYPT, CHINA, ETC., A THOUSAND YEARS BEFORE CHRIST. — HOW COTTON IS RAISED. — THE COTTON GIN DESCRIBED. — AN UNSOLVED PROBLEM IN THE MANUFACTURE OF COTTON. — AN INTERESTING QUOTATION FROM JOHN WYATT'S LETTERS PATENT, 1738. — ARKWRIGHT AND HARGREAVES. — THE PROPORTION OF COTTON GROWN IN THE UNITED STATES WHICH IS MANUFACTURED HERE. — STANDARD FOR JUDGING COTTON FABRICS.

In a history of the great industries peculiar to the present generation, no single element of a purely material character is found so important and influential as the white, downy filaments that enclose the seed in a pod of the cotton plant. A generation ago the woollen interest was mighty, the industries of iron, and coal, and brass, and silk were well developed, while that of cotton was in its infancy. When General Burgoyne surrendered, and the folly and obstinacy of George III. robbed the British empire of its richest possessions, the cotton imported into England consisted of a few thousand bales of yellow short staple from East India. During those eventful years, from 1760 to 1780, when the rashness and stubborn pride of England's rulers were doing so much to cripple her power, four poor and humble men — mechanics — with blackened hands and fustian jackets, were developing machines the effect of which has been to restore to England more than she lost at Saratoga and Yorktown. A century ago England aspired to govern half the world by the skill of her generals, the valor of her soldiers, the audacity and genius of her statesmen. Now she dictates prices, and governs with a sway that cannot be broken in the world of commerce; and this is done by her amazing power of gorging every mart of the world with the products of her looms. This she can do because Wyatt, and Arkwright, and Hargreaves, and Crompton, by their wonderful devices, have taught her how one man may do the work that two hundred men did be-

fore, and show a better and more uniform product than the most skilful of the two hundred could have done without their machines. The carding rollers, the drawing frame, the jenny, and the power loom, in their exact adaptation to cotton fabrics, created at once a keen demand for that product; and in the early part of the century, a Yankee inventor gave southern agriculture the one machine that was needed to place cotton among the leading material powers of the world. With Whitney's cotton gin in our southern states, and the great inventions alluded to in England, the equipment was complete. England and the north-eastern states could spin all the cotton the South could grow. Enormous mills went up, rural population flocked to manufacturing centres, cloth merchants opened branch houses in China, in India, in Brazil, in Africa, and Australia. Then our cotton-producing states, conceiving that a control of a staple of such importance was virtually a control of the commercial interests of the most powerful nations on earth, proposed from that vantage-ground to dictate fundamental laws between capital and labor for the whole continent to obey, and thus originated our civil war. Great credit is given to John C. Calhoun, the radical in politics, for sowing the seeds of that strife; but when the remote, but efficient, cause is discovered, we see not a theorizer, but a mechanic — not a Calhoun, but Eli Whitney.

Cotton fabrics are nearly as old in history as fabrics of wool and silk. The Egyptian dead who were embalmed when Joseph was prime minister of Pharaoh were swathed about with fine cotton cambric. The Hindoos and Chinese used it with silk as a national staple for clothing a thousand years before Christ. The East India spinners and weavers became renowned for the fineness and beauty of their lawns many hundred years ago. With the rudest and most clumsy looking machines, a woman, sitting under a palm tree on the edge of an oblong pit, with threads tied to her toes, could produce a gauze so uniform and delicate that, when wet and laid upon the grass, the eye could barely detect a film spread over the green blades. The latest and utmost skill of English artisans has recently been able to rival, but not to surpass, in delicacy and perfection the fabrics that Indian females could produce with a few bamboo sticks. The peculiarity of modern manufactures is not that better cloths are produced, but that the forces of nature have been so skilfully harnessed that the operations which man once *performed* he now simply *directs*. Iron,

water, steam, all mechanical powers, all chemical agents, are his faithful drudges, and not only yield their amazing forces to his command, but execute works more subtile and delicate than he could accomplish by dexterity alone.

The observation and experiments of many centuries have developed but four materials or sources of the clothing of the race. Two of these are in the animal kingdom, and two are in the vegetable kingdom — silk, wool, linen, and cotton. A walk across one of our southern plantations, and a calculation of the moderate amount of labor by which a large quantity of cotton wool is produced, will show that when the beauty, warmth, and durability of cotton are considered in connection with the ease with which it is grown, this plant is and must continue to stand in the front rank as *the* material for the clothing of mankind.

Cotton is planted in rows about four feet apart, and the stalks are cut away from the first stand, or sprouting, till they are about two feet apart in the row. Thus planted, the boughs of the plants by the month of July touch each other across the middles, and the entire field is covered, so that, in good land, not a spot of earth can be seen except as the thick branches and leaves are pushed aside. Early in the month of August, the pods which contain the seed and the enveloping wool begin to burst. Then picking commences. The first pods to open are those first formed on the larger and earlier stalks. As the season advances, other pods growing on the middle and top branches of the plant expand, and the snowy wool, pushing out from the crisp segments of the pod, gives a white and beautiful appearance to the whole field. So profuse is this crop of vegetable wool that a prosperous plantation in the month of October, when the greatest number of bolls are open, looks as though a shower of snow-flakes had fallen, and the white mantle had not been blown or melted from the surface of the vegetation. One man can easily plough, plant, and cultivate ten acres of cotton. A good yield is a bale or bag of four hundred pounds for each acre. The labor of one man and one mule produces, then, in a good season, and on good soil, four thousand pounds of material for cloth. On an average, as cloth is made, each of those pounds will be converted into four yards of cloth. Thus, one man laboring in the cotton field can give society the raw staple for sixteen thousand yards of cloth. It would task the activity and care of the same man to take charge of one hundred sheep that might yield a clip of four hundred pounds of wool,

to provide supplies for wintering them, and to shear the fleeces. In this view of the case, the raw material for cotton spinning can be produced with about one tenth the ease that the same quantity of wool is given to the manufacturer.

In an important sense of the word the manufacture of cotton begins at the plantation and the gin-house. After the lint, or wool, has passed through one stage of the process, it is packed closely in square bales, hooped with iron, and sent many hundred or thousand miles to the pickers, rollers, throstles, and jennies that convert it into yarn, and the looms that make cloth of it. A cotton gin is, in its essential parts, a series of circular saws, with fine hooked teeth on one cylinder, which revolves rapidly against a mass of the seed cotton as it comes from the field. Cotton wool is a species of hair or down that grows out of the seed and envelops or wraps it. The seed is somewhat smaller than the common field pea, and when the down, or lint, is pulled away from it, shows a black and rather oily husk. The weight of the seed is about thrice that of the enveloping wool. Thus twelve hundred pounds, as it comes from the field, will be separated by the gin into three hundred pounds of lint and nine hundred of seed. Back of the saw cylinder is a revolving brush which removes the lint from the teeth, and a blast of air from a fan blows the lint away from the brush, and throws it back in a snowy shower into the lint room. It is one of the unsolved problems of political economy in this country how to unite the manufacturing with the cotton growing interest, so as to bring the carding mill, the roving frame, and the jenny to run by the same power that drives the gin. The loss of time, and power, and material by thus interrupting the process, packing the lint, compressing and hooping it, removing it to the factory, where there are other machines for picking it light and whipping out the dust, is very great. When a mass of cotton wool is made fleecy and wholly freed of dust, it is ready for the carding rollers. These draw the staple out into fine parallel threads, or filaments, and wind them around a large cylinder. A device not unlike a fine steel comb removes them from the cylinder, and by a slow, gentle motion these fine fibres are drawn together into a long, white roll or cloud-like rope, that parts at a slight pull. The great inventions which have given cotton manufacture such impetus take up the staple at this point. This soft rope, or tube of fibres, held so loosely together, must be very gently drawn out and compacted. Perhaps the mode of doing

this cannot be better stated than in the letters patent granted to the invention of John Wyatt in 1738. It is copied from the close rolls of George II., the twelfth year of his reign, and the quaint spelling of that age is retained: "One end of the mass, rope, thread, or sliver is put betwixt a pair of rowlers, cillinders, or cones, or some such movements, which, being twirled around by their motion, draw in the raw mass of wool or cotton to be spun in proportion to the velocity given to such cillinders. As the prepared mass passes regularly betwixt these rowlers, cillinders, or cones, a succession of other cillinders, moving proportionably faster than the first, draw the sliver or thread into any degree of fineness which may be required. Sometimes these successive rowlers have another rotation besides that which diminishes the thread, and they give it a small degree of twist betwixt each pair by means of the thread itself passing through the axis and centre of that rotation."

Here we have the essential thing in roving and spinning by rollers — a sliver drawn down to the required fineness by a difference in the velocity of two cylinders between which it is carried and the twist to be given it by connecting the thread with the motion at the axis of the cylinder. Thirty years this plan, thus clearly stated, slumbered in the close rolls, and then was taken up by a patient and resolute inventor, Sir Richard Arkwright, who, in the midst of difficulties, and in poverty so great that his friends made up a purse to buy him decent clothes, kept on with wheel, and cog, and cylinder, and bobbin till he gave the world the throstle and water frame substantially as now is used in a thousand cotton mills.

About the same time — that is to say, a little over one hundred years ago — another great invention took up the cotton where the drawer of Arkwright left it, and made yarn of it. This invention was the *jenny*, and Thomas Hargreaves, illiterate and humble, a weaver of Stand Hill, near Blackburn, was the father of it. He is said to have received his original idea from seeing a common one-thread hand wheel overturned upon the floor, when both the wheel and spindle continued to revolve. Why could not a row of spindles be set side by side? Why could not one band drive them all?

Why might not some mechanical device let through just so much roving or soft thread for each spindle, and so one spinster make eight, sixteen, thirty-two, or more threads as easily as she

now makes one? These problems Hargreaves puzzled over for months, and with much casting, and filing, and adjusting, contrived a frame, in one part of which he placed eight rovings in a row, and over against them eight spindles. The rovings, when extended to the spindles, passed between two bars of wood, forming a clasp, which opened and shut somewhat like a parallel ruler. A portion of the roving, or roll, being extended from the spindles to the wooden clasp, this was closed and drawn out on the horizontal frame to a suitable distance from the spindles, thus making the thread fine enough; at the same time, by turning a crank, the eight spindles were made to spin eight lengths of yarn, and by opening the wooden clasp the spun thread could be run back and wound about the spindles. He soon saw that sixteen spindles could be turned by the same wheel by which the eight were driven; and if sixteen, why not thirty-two? why not sixty-four? His discovery it was that gave cotton manufacture its amazing impetus. Before, it had crept along the earth; now, it took on wings, and could speed with a geometric velocity.

One invention, or rather one combination, more was needed, and this was devised by Samuel Crompton. He joined the drawing machine with the jenny, and instead of moving out with the roll, the spindles being fixed, he reversed the process, and took the spindles out on the roving frame, *spinning as he drew out.* It is clear that he could get a much finer thread by this plan, as, by twisting, the thread constantly grew more compact as it was drawn out. This combination he named *the mule.* With it he made yarn never before equalled in England for fineness and uniformity. Other and more skilful artisans made mules. William Kelley, of Lanark Mills, first turned the mule by water power in 1790. Soon after a double mule was made, then the unheard-of exploit of working no less than four hundred spindles on one frame, and of late, in Manchester, Eng., and elsewhere, eight hundred spindles each on a double mule have been used, and in some mills the prodigious number of eleven hundred spindles each, or twenty-two hundred the pair, all managed by one spinner.

About forty years ago one Roberts, an ingenious machine maker, contrived an automatic mule that could roll out several hundred spindles on one frame with a perfectly uniform motion; and at a given time, when the revolutions had made the thread hard enough, it returns, winding the spun thread on the spools, and goes out without aid or touch of hands, thus dismissing the spinner, or

making him merely a looker-on, to mend a broken thread or throw off the band in case of accident.

In order that weaving might keep pace with the rapid production of yarns, several inventors and machinists wrought upon the power loom and on the dressing and sizing apparatus necessary to make the power loom in every respect more rapid and economical than hand weaving. These labors were consummated a little more than forty years ago, when the series of grand inventions culminated in giving England and America the facilities we now have for converting our immense cotton crops of four million bales each into cloth, and performing all this Briarean labor by the gravitation of falling water and the expansion of steam.

Of the cotton grown in this country we manufacture about one fourth or one fifth. That is to say, of a four million bale crop, somewhat over three millions are exported, and from eight hundred thousand to one million bales are converted into cloth, mostly in the north-eastern states. The standard for judging of the weight and durability of a cotton fabric is the number of threads in a square inch. Some cambric shows a network under the glass of 92×96 threads in each square inch. Some standard sheetings show 64×64. Of the million bales spun by us, full one half is made into such coarse, durable fabrics as the Osnaburgs, Attakapas jeans, and Alabama plaids.

While the Manchester, Eng., mills are much more numerous than any of our manufacturing towns can boast, and are engaged mainly on the finer grades of muslin, which require nicely-adjusted jennies and mules, it is justly a matter of pride with the American spinners that our mill hands are more intelligent, more cleanly, and better paid than the English operatives.

CAOUTCHOUC, OR INDIA RUBBER.

THE MODERN INTRODUCTION OF INDIA RUBBER. — THE VARIETIES OF THE NATURAL PRODUCT. — THE TREES WHICH YIELD IT. — WHERE THE BEST QUALITY COMES FROM. — THE PROCESS OF GATHERING IT. — ITS CHEMICAL ANALYSIS. — THE PROCESS OF WORKING. — CHARLES GOODYEAR. — VULCANIZED RUBBER. — THE USES OF THE NEW MATERIAL THUS MADE. — THE VALUE OF THE MANUFACTURE.

THE use of Caoutchouc, or India rubber, and its application to the numerous purposes for which it is employed, is an industry which has been developed within a very short time, and affords a striking instance of the difference between the industrial methods of an uncivilized people, and one which has arrived at a knowledge of the laws of chemistry, and is able to apply them practically to the arts.

The history of the gradual steps by which the qualities of India rubber became better known, and improved methods of treating it were discovered, so that the area of purposes to which it is applied was constantly widened, shows conclusively the importance and the value of a theoretic knowledge of science, as a basis for its practical application to the arts. India rubber is the juice of a tree which is found in various parts of South America, and also in the East Indies. The natives of South America gave the name *cahuchu* to the hardened juice, from which our word *caoutchouc* is derived, while the term *India rubber* came from the application of this material, derived from the East, to the purpose of rubbing out marks made by the ordinary lead pencils.

There are several varieties of trees from which this product is obtained, and the American tree has been thus variously named by botanists: Linnæus calls it the *Jatropha elastica*; Persoon, the *Siphonia elastica*; Schreber, the *Siphonia cahuchu*; and Aublet, the *Hevea guianensis*. The trees which furnish the chief

supply from Asia are the *ficus elastica*, belonging to the fig family of trees, and others which furnish an inferior quality of this material. This *Ficus elastica* is one of the noblest trees in the world. It grows either alone or in groups of two or three. The circumference of one which was accurately measured was seventy-four feet, while the girth of the main trunk, with the supports immediately about it, was one hundred and twenty feet. The height of the central tree was one hundred feet, and it covered an area the circumference of which measured six hundred and ten feet.

In Assam, in the district of Chardwar, there is a forest near Ferozepoor, in which over forty-three thousand such trees were counted in a space thirty miles long and eight broad. This tree flourished on the hill slopes, reaching an elevation of twenty-two thousand five hundred feet. It belongs to the banyan tribe of trees, which spread by the rooting of the branches. In the district of Chardwar, the juice of the *Ficus elastica* is considered to be better when drawn from the old trees than when taken from the young ones, and richer in the cold than in the hot season. It is obtained by making cuts through the bark down to the wood, all around the tree from the trunk up to the top, including the main branches, the yield increasing with the height of the incision. The juice, when first drawn, is pure white, and about the consistency of cream. The yield is about forty pounds each bleeding, which can be repeated on an average once a fortnight during the cold season, so as not to interfere with the healthy vegetation of the tree during the hot months.

The richest juice is said to be obtained from tapping in the same way the roots, where they turn and are half exposed above the ground. By being guarded from exposure to the air, or to too great heat, the juice can be kept in a creamy state for a long time. In South America the chief supply of caoutchouc is obtained from the district of Para, lying south of the equator, in Brazil. The trees are tapped each morning, and during the day about a gill of liquid is secured from each incision in a cup placed for its reception. This is then poured into a jar, and is ready to be made immediately into the various articles of rude manufacture, in which form the natives prepare it for export. Clay moulds of bottles, shoes, or other forms, are dipped into the fluid mass, and the coating which adheres is dried, and then thickened by a repetition of the operation. It has also been exported in its liquid form, in airtight vessels prepared for this purpose.

By chemical analysis this gum has been found to be hydrocarbon, consisting of eight equivalents of carbon to seven of hydrogen, which would give the proportion of carbon 87.27, and of hydrogen 12.73 in 100 parts. This was very nearly the result of Faraday's analysis. Another, made by Mr. Ure, gave 90 parts of carbon and 10 of hydrogen, being three atoms of the former to two of the latter.

In his work upon *Perspective*, printed in 1770, Dr. Priestley, who was one of the founders of the modern science of chemistry, speaks of caoutchouc as a substance which had just been brought to his notice, as admirably suited for rubbing out pencil marks. He states that it was then sold at the rate of six shillings the cubical inch. Some of the properties of this material were known to the natives of South America at the time of the Spanish conquest. They used it for making their drinking utensils, and for other purposes. In this form it had been carried to Europe, and re-worked into such forms as Priestley mentions.

The increasing activity of chemical research occupied itself with this substance soon after Priestley's time, and various applications of the peculiar qualities of this substance were suggested and practically realized. The best qualities of this gum are obtained from South America, and as imported, in either the rough or manufactured state, it is re-worked by being first broken up into small pieces, which are washed and kneaded with water in mills of a peculiar construction. These mills are furnished with knives and iron teeth, which cut and grind the pieces. So much heat is evolved in this process that the water boils, and the charge of a mill is limited to only five pounds. Having thus removed the impurities from the crude material, it is again ground, cut, pressed, and pounded in a mill with a little quicklime. Here again it gets very hot, and with a series of explosions and crackling it discharges the water and air it had before absorbed, in steam. After this process is completed, it becomes more compact, and assumes the dark color seen in the rubber sold by stationers. A third process of the same character unites several balls, thus prepared, in one homogeneous mass, which is placed in a box and squeezed by screws to a cake-like form.

After being left for some days thus compressed, it is then taken out and cut into small cakes, or into threads, as may be desired. The knife with which this is done must be very sharp, and a stream of water must flow constantly in the cut in order to pre-

vent the two sides of the divided cake from instantly uniting again, or sticking to the blade so as to prevent its working. When it is cut into threads for weaving into the various elastic fabrics which are made from it, these threads are stretched about eight times their original length, by being held tightly enough to produce this effect between the wet thumb and finger of the operator. In this process, as always when the rubber is stretched, heat is evolved. The threads thus treated are rendered unelastic, and being afterwards covered with braid in a machine, are woven into ribbons or textures of the kind that may be desired.

The elasticity which the rubber in the fabric has lost during the process described above, is then restored to it by pressing the fabric with a hot iron. In thus regaining its elasticity the rubber contracts to its former dimensions, and thus are produced the fabrics which seem to have been fluted or crimped. Caoutchouc can be dissolved in petroleum (coal tar), naphtha, or oil of turpentine ; and when this is done the result is a varnish which is used to make water-proof clothing. Heated to about the temperature of 600° F., caoutchouc passes off in a vapor which, by proper appliances, can be condensed into a liquid which is called *caoutchoucine,* and is distinguished for its solvent properties, both on caoutchouc itself, and all other resinous and oleaginous substances. It is itself extremely volatile, but its vapor is so heavy that it can be poured from one vessel into another.

With the increasing variety of purposes to which caoutchouc was applied, the attention of inventors and chemists was directed towards the discovery of some method of rendering it insensible to the effects of cold. Its tendency to stiffen at the temperature of 40°, thus losing its elasticity, rendered it ineligible for various purposes. The first successful method of *vulcanizing* India rubber was patented in 1839 by Mr. Charles Goodyear, as assignee of Nathaniel Hayward. Mr. Goodyear had for years been experimenting with the intention of inventing some method for treating India rubber so as to make it of greater value in the arts. In September, 1835, he had taken out a patent for treating the surface of native caoutchouc with nitric acid, so as to remove its adhesive properties. This first method of vulcanizing rubber was found to be imperfect, the process being to mix it with sulphur, which preserved its offensive smell, and did not entirely prevent its becoming rigid under the effects of cold. Having improved the process by the use of sulphur and certain salts of lead,

Mr. Goodyear took out another patent in 1844, which was reissued in 1849, extended in 1858, and again reissued in 1860.

The material produced by this new process possessed peculiar qualities. It was more perfectly elastic than common caoutchouc, resisted the action of the ordinary solvents of that material, was better able to resist the wear and tear of its surface, and preserved its flexibility at all temperatures. Then Mr. Nelson Goodyear patented a process for solidifying rubber, making it susceptible to a polish, capable of being moulded into any desired form, and thus completed a series of inventions which are among the most valuable in the present century, as having opened entirely new fields to industry.

To attempt to enumerate the various uses to which rubber is now applied would be almost to write a catalogue of the various utensils needed in the various occupations of our daily life. It is made into tires and springs, jewelry, combs, knife handles, boxes, drinking cups, coats, tents, and life preservers, water beds, and shoes, and a patent has been taken out for making from it rails for railroads. The history, too, of the determined and expensive litigation which ensued upon the enormous extension of the business which these discoveries gave rise to, would be too long to enter into here, but will long be remembered in legal and industrial circles. From being merely valued as a curious natural product in the early part of this century, caoutchouc has now come to be the material used in manufactures which amount to millions yearly.

THE PITCH-PINE AND ITS PRODUCTS.

THE PINE FORESTS OF THE UNITED STATES. — THOSE OF EUROPE. — SPIRITS OF TURPENTINE. — THE PRODUCTS OF THE PINE. — ARTIFICIAL CAMPHOR. — CAMPHENE. — ROSIN. — VIRGIN DIP, YELLOW DIP, AND SCRAPE. — PROCESS OF GATHERING. — DISTILLATION. — IMPROVEMENTS IN THE PROCESS OF MANUFACTURE. — THE EFFECTS OF THE LATE WAR ON THE BUSINESS. — THE PROFITS OF THE BUSINESS. — TAR. — THE PROCESS OF MAKING. — THE EXTENT OF THE BUSINESS.

COMMENCING in the southern half of New Jersey and extending as far to the south-west as the river Brazos in Texas, is a broad belt of country covered with a heavy growth of pitch-pine. The soil on which this tree is found is noted for its sterility. Tillage of itself hardly supports the sparse and ignorant population which has drifted in, and for generation after generation lived upon these sandy barrens, and they are forced to eke out a miserable support by the industries to which the forests around them have given birth. The region covered by the forests which produce the naval stores of the world embraces the eastern part of North and South Carolina, the southern parts of Georgia, Alabama, Mississippi, Louisiana, and the northern part of Florida.

This southern pine, as it is familiarly called, is known among botanists as *Pinus Australis*, and comprises several species. These differ chiefly in the length of time they yield the gum, for which they are valuable, — those in North Carolina lasting for ten years, while in Florida six years is the average limit of production. The pines of Sweden, Norway, and the south of France supply small quantities of naval stores; but their forests are of a species greatly inferior to ours, since they do not yield as much, nor for so long a time, as those of the Southern United States.

Though the gum or resin from which spirits of turpentine is made was known to the ancients, this volatile fluid is of comparatively recent discovery, and it is only within the last forty years that it has risen to the dignity of an article of commerce. For some years previous to this the spirits of turpentine derived from the Euro-

pean pines was used to a limited extent for medicinal purposes. Its great production and extensive use in this country is due to the introduction and universal application of paints, and the necessity for having some volatile vehicle to mix with the oil.

The products of the pine are four in number,—rosin, gum or crude turpentine, tar, and pitch. The last two were made by the earliest settlers of our country, and formed an important item in the exports of the Carolina colonies. They have been known from the earliest recorded time, and have always been, as they are now, chiefly used in calking the bottoms of vessels. Chemically, these four substances are compounds of hydrogen and carbon, varying in nature and proportions in the same way as do the various products of coal-oil, petroleum, naphtha, and asphaltum. Spirits of turpentine presents a fine illustration of one of the marvellous revelations made known by chemical science. The constituents of this liquid and of the oil of lemons are hydrogen and carbon in precisely the same proportions, and yet no means of converting the one into the other has ever been discovered. Nature, mighty alchemist that she is, manufactures in her secret laboratory, from the same materials, compounds differing from each other thus widely, and man vainly endeavors to find the secret of her skill. As a medicine, spirits of turpentine is diuretic, and so powerful is its action that sailors on vessels loaded with a cargo of this material are sometimes dangerously affected by the evaporation from the leaking barrels. It is used also in rheumatism and similar affections, but if the application is long continued the joints and muscles become injured. By chemical operations, spirits of turpentine is resolved into a number of substances of no particular value, the most curious of which is artificial camphor,— so called from its singular resemblance in odor and appearance to that gum. It is made by the action of hydrochloric acid on the spirits of turpentine. One of the most powerful solvents of caoutchouc, or india-rubber, of many of the gums and resins is spirits of turpentine. It possesses electrical affinity and polarizes light; it absorbs ozone to such a degree, that, if left standing a length of time, it acquires the power of bleaching vegetable colors. In the art of painting, no substitute for it has ever been obtained, though the scanty supply from 1860 to 1865 stimulated much endeavor in this direction. The various light products of petroleum were used for a time, but were abandoned as soon as spirits of turpentine could be again obtained. Low grades of white paints are made whiter by its use, while those in

which benzine is used readily turn yellow. Formerly a burning-fluid called camphene was made from spirits of turpentine. This was done by mixing with it alcohol and re-distilling the compound, but since the introduction of coal-oil the manufacture of camphene has entirely ceased.

A substance strongly resembling spirits of turpentine, though much less valuable in its properties, is obtained by dry distillation of pine wood. This fluid is an excellent solvent of gums, and when deodorized can be used for light varnishes, or for dissolving aniline crystals, in place of alcohol, which is much more expensive.

The article known to commerce as rosin is a brittle, vitreous substance, melting at a low temperature, and varying in color from a blackish red to a pale, transparent yellow. When white and opaque it contains either water or spirits of turpentine. It is used in small quantities in a thousand different ways, but the chief ends to which it is applied are the adulteration of soaps and varnishes. Strict inspectors class it according to color and transparency into thirteen grades. The common black grade is generally used by small towns and hotels for the manufacture of gas, since gas derived from rosin keeps longer without spoiling than that made from coal. Our manufacturers use it in their size, and even the bill-poster must have a little lump in the paste with which he fastens up to our gaze his great show-bills. Large quantities of the black grades are used to make rosin-oil, from which gas is manufactured, and which in a refined state is employed to adulterate other oils.

Rosin and spirits of turpentine are both derived from crude turpentine. This is the sap of the tree, and is technically known as virgin dip, yellow dip, and scrape. The first is the product of the tree for the first year after it is tapped. When of good quality, it is limpid as honey and of a pale straw-color; exposure to the air soon causes it to grow opaque and creamy. From the virgin dip are made the beautiful pale grades of rosin. A barrel weighing two hundred and eighty pounds yields seven gallons of spirits and about one hundred and eighty pounds of rosin. This dip is used to a limited extent for making plasters and salves. The product of the tree for the second and several succeeding years is called yellow dip. This yields more rosin, but not so much spirits. "Scrape" is the term applied to the sap which exudes from the tree, during the last two or three years of its productiveness. It is a waxlike substance of great whiteness when first taken from the tree, but soon turned yellow by exposure to the air. It is used in small quantities for

various purposes, beside distillation, one of which is the making of frankincense. Taken in small pills, it is an excellent medicine for removing obstructions of the liver and kidneys, and for promoting activity in the general secretions. By distillation it yields a much smaller quantity of spirits than can be obtained from the products of the previous years, but a larger proportion of rosin, and of a grade scarcely inferior to that from the virgin dip.

The mode of gathering these products and their preparation is as follows. A cut is made in the tree as near the roots as possible, which, on the outside, is shaped like a half-moon; it extends several inches into the tree, forming a pocket, and is large enough to hold one or two quarts of sap, according to the size of the tree; sometimes two or three boxes, as they are called, are cut in one tree. A good hand will cut from one hundred to one hundred and fifty in a day, according to their size, and on an acre of trees from five hundred to one thousand such boxes may be made. They are usually cut at so much a box, from a cent to a cent and a half each. After the boxes are cut they are counted off into tasks, generally of ten thousand each, and a laborer assigned to every task. If it is an early, warm spring, by the time each task has been cut and counted the boxes are full and must be dipped out. For this a flat spoon-shaped instrument and an ordinary bucket are used. The man carries the bucket on his arm by an arrangement like that employed in fastening on the shield of former times; he pushes it up against one corner of the box, inserts his dipper, and, by a dexterous flirt, throws out the gum. A practised hand will frequently clear the box at one dip. When the bucket is full it is emptied into a larger one, and from that poured by another hand into barrels which are placed at convenient intervals among the trees. Just after the first dipping the boxes are usually cornered. This is done by taking out a triangular chip at each end of the half-moon. If the season is good, by the time the laborer has cornered his whole task the boxes will be again full. They are dipped out for the second time and then given two cuts on each side with the "hack." This is an instrument resembling a gouge, and the operation of "hacking" consists in taking out a circular chip along the edge of the place where the "corner" chip was previously cut out. These strokes slope downward to the centre of the box, so that the gum will all run in that direction. A box is usually given about fourteen strokes each year at seven different rounds. These will cover a space from one and a half to two feet in height, and as the trees are seldom

worked more than from fifteen to twenty feet in height from the ground, this space will be gone over in about ten years. They are seldom worked much longer than this, since they are of small profit after the first three or four years, but, as they have already paid for themselves, what they yield after this period is clear gain. The tasks are usually assigned to a man called the "hacker," who takes the whole by contract and employs the dippers. In other cases two dippers generally follow one hacker. When the trees are worked to much height the hack is fastened to a long pole and the man who gathers the "scrape" is obliged to use a ladder. During these latter operations a round-share is used to scarify the whole face of the box and make the gum ooze out more freely.

The boxing must be done after the sap falls in November and before it commences to rise in the spring. If there are five hundred boxes to the acre, twenty acres will be required to make a task of ten thousand boxes. Two hundred boxes to the acre is all, however, that the average forest will allow. This would give fifty acres to the task. The value of virgin land or round pine as it is familiarly called, is seldom over five dollars an acre, and frequently less than that. Allowing five hundred boxes to the acre, the capital invested in a task of ten thousand boxes would be for land one hundred dollars; boxes, one hundred and fifty dollars; tools, fifty dollars; in all, three hundred dollars. Supposing there are but two hundred boxes to the acre the investment would run up to five hundred and fifty dollars. From this fifty acres may be gathered the first year at least two hundred and seventy-five barrels of virgin turpentine, worth in market not less than four dollars a barrel, in all eleven hundred dollars. The hacking and dipping continues from April 1 to November 1, about seven months, the total cost for three hands being sixty dollars a month, or four hundred and twenty dollars for the season. The hauling may be contracted for at about ten cents a barrel, making the sum-total of nine hundred and ninety-seven dollars and fifty cents. Hence in a good season, with care and economy, the land and the labor may be paid for the first year and handsome profits be derived from the operations of each succeeding year.

So far we have spoken only of the production of the gum or crude turpentine. To obtain the spirits and rosin the gum must go through a process of distillation. This operation is conducted in large turnip-shaped stills, made of copper and set in brick-work, the fire being applied directly to the bottom of the still. The stills will

hold ten, fifteen, twenty, and sometimes forty barrels of gum. This is "charged" in at the top and the cap fitted on. This cap connects by an arm with the worm, around which cool water is constantly running. When the still is filled and this connection made, the fire is applied. As the process of distillation goes on, the distiller adds from time to time a little water to prevent scorching, and tries his "charge" by inserting a rod in a small hole in the top of the still intended for that purpose. When the process has reached a certain point he draws his fire and allows the still to cool a little; then he takes off the cap and from the liquid mass inside skims off all the chips and bark, of which there is always more or less in the gum. If the cap is taken off too soon, the whole charge will take fire from rapid oxidation. When the hot rosin is cooled down, it is drawn off through a pipe at the side of the still near the bottom, and passes through strainers into a wooden tank, from which it is dipped into barrels. Upon the care taken in straining the rosin depends much of its value in market; hence, certain brands made by careful men soon become known and command high prices. The spirits, being condensed in the worm, run out, mingled with considerable water, into a tub, the water, on account of its greater specific gravity, settling at the bottom. From this tub the spirits are syphoned off into well-glued barrels for shipment. Though this whole operation is one of great simplicity apparently, yet to insure a good article and a high price much care and strict attention is required in conducting it. A little carelessness may result in a fire which will destroy in a day two or three years' profit. Though the distilling is generally a separate business from gathering the gum, the two are sometimes conducted jointly.

The second year's product, called yellow dip, seldom yields over six gallons of spirits to two hundred and eighty pounds of crude turpentine, and from the scrape only three or four gallons are obtained; but these two products yield proportionately larger quantities of rosin. Many slight improvements have been introduced during the last few years, which cheapen the cost of producing and improve the quality of rosin; one of these is the straining of the rosin through beds of cotton lint. The quality of all the grades is better within a recent period than ever before. The margin of profit in these pine industries has hitherto been so small that costly experiments have not been tried, and steam has not been successfully used as a heating agent.

The largest distillery in this country is at Wilmington, N. C.,

and is capable of managing over five hundred barrels daily of gum turpentine. Previous to 1860 many stills were located at a distance from points of public transportation, and hauling became a great item of expense. Hence the spirit was sent to market, and the rosin, not paying for transportation, was run into pits or at random over the surface of the ground, sometimes covering acres a foot or two in depth. In time this became very hard from being mixed with sand, and of a light color from oxidation and absorption of water. A part of the Twentieth Corps of General Sherman's army, when on the grand march, encamped on one of these broad, smooth rocks, as they supposed it to be, and constructed a bridge upon a creek near by. As the camp-fires glowed and crackled, the semi-rock warmed and kindled, and soon both camp and creek were a mass of liquid fire. Water only increased its fury, and for once the corps had to back out at a double-quick, seeing bridge and all licked up in the seething mass, while the waters of the creek flowed a stream of living fire, and the clouds of smoke hung over them a vast black canopy, completely shutting out the light of the moon. Some who read this may remember the awful splendor added to the battle of Bentonsville by the firing of the extensive beds of rosin at that place. It is said that the rebels in deserting Wilmington burned over one hundred and fifty thousand barrels of rosin to keep the United States from its possession. After the close of the war, the high price of rosin caused many of these beds to be dug up, and thus great quantities of rosin of a very low grade were forced upon the market. This resulted in a rapid fall of prices and a general depression of the business, from which it has only this year (1871) in a measure recovered. This season, the prices have been at rates highly remunerative. The cost of a still and fixtures varies from one thousand to five thousand dollars, according to size; a store is usually kept in connection with a distillery. The profits of carrying on a distillery may easily be calculated. Three barrels of crude turpentine cost twelve dollars and yield two barrels of rosin worth ten dollars, and about twenty-two gallons of spirits worth forty cents a gallon, or eight dollars and eighty cents, making six dollars and eighty cents gross profit on every barrel.

Tar is produced by the smothered burning of the trees no longer valuable for turpentine, of those deadened in clearing land and from stumps of trees cut down for lumber. The sap continuing to rise in old turpentine trees oxydizes near the scarified surface, and changes the nature of the wood, which is called lightwood from its readiness

in kindling. This also occurs in the stumps of trees cut down at certain seasons of the year. This wood ignites almost as readily as gunpowder, so highly charged is it with pitchy matter, which greatly increases its weight. These trees or stumps are split into billets three or four feet long, and about three inches in diameter. In forming a tar-kiln the earth is scooped out of the ground, leaving a saucer-shaped excavation from the centre of which a tube runs underground to the outside of the rim. The billets of wood are then so placed as to radiate from this centre and point upward, each upper and outer stick lapping a little over the one below, so that, when finished, the pile resembles a truncated cone. Green twigs and dirt, with logs of wood as braces, are then piled around, until the pile resembles a perfect cone; the kiln is then covered all over with dirt, except the extreme edges, where it is fired. As the smothered heat extracts the tar, it trickles down to the centre of the pile and passes through the pipe to the outside. Great care is requisite to keep the flames from bursting out, and a large kiln must be watched night and day for about ten days. Kilns vary in size, yielding from fifty to a hundred and fifty barrels of tar. As the wood generally used is refuse, and the labor done in the winter season or at odd times, the product of a tar-kiln is nearly all profit. No improvement on this old style of tar-making has been adopted, the value of the product not stimulating advance in this direction. In the dry distillation of pine wood, already alluded to, a species of tar is produced which answers many purposes, though it more nearly resembles pitch than tar. Pitch is simply tar boiled until freed from its volatile matter, — water, spirit, and oil. Tar does not harden when spread upon a surface; pitch hardens, and at the same time has great elasticity. The charcoal made by dry distillation is better than that made in the open-air kilns. In the days before the war, the burning of a tar-kiln was a frolic similar to corn-huskings and quilting-bees. Amid the dreary grandeur of the southern pine forests the burning of a large tar-kiln presents a sight of great excitement and interest. The immense columns of smoke lazily floating away in the damp air, now and then a tongue of flame leaping out, the quick rush of the men to cover it with dirt, their wild, eager cries, — amid the spectral shadows which on every hand people the mighty forest as with the ghosts of trees sacrificed to the commercial uses of mankind — all these sights and sounds make this winter frolic a festivity which, once enjoyed, can never be forgotten.

In 1860 over five millions of dollars were invested in this business, and there is scarcely less than than amount now. North Carolina then produced nearly one half of all the naval stores yielded by the pine forests of the United States. In 1870 she produced three fifths of this sum-total, but this year (1871) the other States are increasing their yield while that of North Carolina is diminished. In 1868 the turpentine-producing States paid an internal-revenue tax of $402,836.83 on spirits of turpentine alone, after which year the tax was abolished.

Exports in 1860:—

Spirits Turpentine	$1,916,289.00
Rosin	1,818,238.00
Tar and Pitch	180,404.00

Exports in 1864 (Spirits of Turpentine and Tar were both imported):—

Spirits	$87,988.00
Tar	7,875.00

In 1867 the tide fully turned, and we exported from New York:—

Spirits	$172,223.00
Rosin	1,984,865.00
Tar and Pitch	94,552.00

In 1870 there was exported:—

Spirits of Turpentine	16,466 barrels.
Rosin	392,649 "
Tar and Pitch	13,957 "

This will be largely increased in 1871, as the prices are better and the production greater than in former years.

VARNISH, AND ITS MANUFACTURE.

THE USE OF VARNISH. — THE SUGGESTION FOR ITS INVENTION. — THE DERIVATION OF THE WORD. — THE HISTORY OF THE USE OF VARNISH. — THE MODERN USE OF VARNISH. — DESCRIPTION OF THE MANUFACTURE. — THE MATERIALS USED. — THE METHODS OF MANUFACTURE.

The use of varnish, both as a method for beautifying polished surfaces and for preserving them, must have always impressed mankind with its advantages as much as it does at present. Unquestionably the suggestion for deriving some such process must have arisen from the pleasure felt in the aspect and the touch of the surfaces of many natural objects. The savage, delighted with the beauty and the feeling of a smooth reed, the surface of which appeared as though it was varnished even better than we have the means of doing it now, attempted with greater or less success to give his wooden weapons a similar surface. Attracted also by the sight of effects produced by the many natural gums as they exuded from the trees, he would try to turn them to his own uses; and the success which many of the semi-civilized nations of the present day, such as the Japanese and the Chinese, have attained in manufacturing varnishes which have all the best qualities desired for such a compound, show how successful mankind were in their early attempts to use the natural products for their own purposes.

The derivation of our word "varnish," which in old English was "vernish," like the French *vernis*, the Italian *vernice*, the Danish *fernis*, the Swedish *fernissa*, was most probably from the Latin *vitrinare*, to vitrify, or to give a smooth and polished surface like glass. The evident similarity of the terms used for varnish in the various languages of Europe shows that the art was older than the division of those who use them into their present nationalities; and that with the Latins themselves we of the modern world are using modifications from a still older stock, from the language of our ancestors who lived long before the historic period, and before the emigration commenced which settled over the Europe of antiquity.

From the earliest historic times the use of varnish has been

known. Among the nations of the East, in China and Japan, the art has been brought to great perfection, as our term "japanning" shows. The Egyptians understood it, and the pictures of Herculaneum and Pompeii have kept the bright freshness of their colors in consequence of having been covered with a kind of wax-varnish. In modern times the greater use of furniture and interior decoration, with the more general diffusion of comfort and luxury, has greatly increased the consumption of varnish, so that in the United States alone the annual production is valued at over four millions of dollars, in producing which there are probably at least a hundred manufactories engaged.

The varieties of varnish also produced, in order to satisfy the demand for its use in the various special branches of industry, are much greater than was the case in olden times, while chemistry and the spirit of modern investigation have discovered many new materials as suitable for this purpose, which were not formerly used for it. Varnishes are in almost all cases made by the solution of resinous substances in some liquid which will evaporate in the open air, and thus leave the resinous substance deposited upon the surface, to which the varnish is applied, covered by it as a thin and even coating. The characteristics of a good varnish are that it should remain brilliant after the evaporation of the liquid medium, and present a dry hard surface, instead of a greasy, soft, or tarnished one. It should also adhere closely to the surface to which it is applied, and not be liable to scale off when it becomes dry, even after the expiration of a long time; beside these qualities, it should become as hard as possible without becoming brittle.

As solvents for the resinous gums, the chief substances used are linseed oil, or turpentine and alcohol. The resins are vegetable substances which exude from trees. They are composed of oxygen, hydrogen, and carbon, and are supposed to be formed by the oxygenation of the essential oils. The chief resins used in making varnish are copal, amber, mastic, sandarach, lac, elemi, dammar, benzoin, animé, and caoutchouc. Besides these, gamboge, dragon's-blood, aloes, and saffron are used as coloring matters.

The copal is obtained from Mexico, India, and Africa. The trees which yield it are the *Rhus copallinum* of Mexico and the *Elæocarpus copalifer* of India. In Guinea lumps of it are also gathered by the natives from the sands on the coasts, and another fossil variety, called Higate resin, is found in the blue clay near London, England, and also on the walls of a trap-dike at an old lead-mine in Nor-

thumberland. This last deposit is in flattened drops. Fossil copal has also been found in the East Indies.

Amber is also a fossilized gum, which was furnished by the trees of some former geological epoch. On the Prussian coast, near the Baltic, beds of it are found, and its collection gives the Prussian government a revenue of about twenty thousand dollars a year. Gathering it upon the sea-shore also gives employment to a great number of people. This is done after a storm, when the swell of the waves is moderate. The men wade out, and gather in nets the sea-weed washed up by the storm, and entangled in this are found pieces of amber of various sizes. In mining for it, the amber-bearing beds are sometimes found as thick as two and a half feet. The largest piece of amber known is in the royal cabinet at Berlin, and weighs eighteen pounds. The value of the pieces is not entirely proportionate to their size, but according to their quality, transparency, clearness, and so on.

Mastic is a gum furnished by a shrub growing upon the upper shores of the Mediterranean, and known botanically as the *Pistacia lentiscus*. The name is derived from the Greek word *mastike*, from which the English "masticate" is derived, and comes from the fact that it was formerly, as now, chewed by the natives; the habit of "chewing gum" not being peculiar only to the children of New England. The chief supply comes from the island of Chios.

Sandarach is the product of the *Thuja articulata*, a small coniferous tree growing in the north of Africa, and from there the supply is obtained.

Lac is a resin which exudes from the twigs and branches of various trees in the East Indies when bitten by an insect called the *Coccus lacca*, which swarms upon such trees as provide a milky juice. When the crude article broken from the branches is sold with the twigs, without undergoing any preparation, it is known as "stick lac." When stick lac is broken up, and partially treated with water, it is known as "seed lac." When melted into masses it is known as "lump lac." Melted and strained through cloths, and allowed to harden in thin sheets, which are then broken into pieces, it is known as shell lac. The best supplies are obtained from Siam, and those next from Assam.

Elemi is a resin which is furnished by a great variety of trees, in various parts of the world. That which comes from Holland is supposed to be furnished by the *Canarium balsamiferum* of the Dutch possessions in Ceylon. Another variety comes from Manilla,

another from the Philippine Islands, another from Brazil, and still another from Mexico. This resin is afforded to commerce in a great variety of shapes, colors, and degrees of consistency; and as yet but little is known accurately of its production, or the trees from which it is derived.

Dammar, or damar, is a resin which exudes from various trees in the East India Islands; and in China and Bengal it is used for coating the bottoms of boats, and for similar purposes.

Benzoin is a fragrant resin furnished by the *Styrax benzoin*, a tree which attains considerable size, and is peculiar to Bencoolin, Batak, and Palembang, territories in Sumatra, and Brunai, a territory in Borneo. This tree is cultivated for its yield of benzoin.

Animé, a resin which comes from South America, is supposed to be the product of the *Hymenœa courbaril*, a tree native to that country. It is odorous and soft, and its name is said to be derived from the quantities of insects it generally contains, and which, having been attracted to it, have become embedded in it, so that it appears to be alive, *animé*, with them. But the animé of commerce, and which is mostly used in Europe and in this country, comes from Zanguebar, on the east coast of Africa, and is the hardest and most expensive copal in the market. The principal varieties of copal used in the manufacture of varnish are,—animé, Bonquela, Angola, and Accra from Africa, and Kauri from New Zealand.

Varnishes are generally classified, according to the solvent with which they are made, into ether varnishes, spirit varnishes, volatile oil varnishes, and fixed oil varnishes. Ether varnishes dry so rapidly that they are hardly used at all. The ether evaporates so quickly as to bubble under the brush. Spirit varnishes are generally made with alcohol, and are produced in great variety, the receipts being almost as numerous as the manufacturers, the quantity and number of the ingredients being varied to suit the capricious variations of the demand. Three ways for making the solution are used: the resins are simply digested, by being mixed with the proper proportions of alcohol, and exposed to the sun, or kept in the shade. This process is, however, too slow a one to satisfy the exigencies of our modern industry, though it produces a varnish having the least amount of color. A more rapid process is by heating over a water-bath, but this gives the varnish more color than the first. The third process is heating the varnish over a fire, by which the color of the resin is still more changed, and the color of the varnishes made consequently still higher. As, however, this is the most

rapid process, it is generally employed for manufacturing, when time becomes an important element in their production.

Oil of turpentine is the volatile oil most generally used in the production of varnishes, and the chief varnish in which it is used is copal varnish. In the production of spirit varnishes the methods of preparation and the ingredients are almost always the same.

The chief distinction between spirit varnishes and those made with oil of turpentine lies in the fact that spirit varnishes are injured by being kept a long time, while those made with oil of turpentine are improved by keeping, a more intimate union taking place in time between the resins and the oil. When a picture, for example, is varnished with a newly made varnish, a portion of the oil leaves the resins and combines with the paints; but if the varnish has been made for some six or eight months, this effect is not produced. As the durability of the varnish is almost in direct proportion to the amount of fatty residue from the oil, any cause which removes this will of course affect it.

Fixed oil varnishes are made almost entirely of linseed oil, which is the oil obtained by pressure from flaxseed. Poppy oil is sometimes used as a substitute, but is most generally mixed with a large proportion of oil of turpentine. The resins used for the making of such varnishes are almost exclusively the varieties of copal and amber. As these solvents are the slowest in drying, and leave the largest amount of residue, the varnishes made in this way are the longest in drying, but are the most durable; and the fixed oil varnishes are consequently used for all purposes where the spirit and turpentine varnishes are unsuitable on account of their want of resistance to the action of the sun's light and heat, or of exposure to the weather. For interior work they are also the best, where their color is not objectionable, since they are more durable, and can be washed without injury; and also as the objection to their use from the slowness with which they dry can be easily obviated by the use of "dryers,"— some substance which will expedite their drying. For this purpose oxide of lead is generally used.

As copal is harder to dissolve than other resins, a different process is employed in making varnishes from it. It is first melted over an open fire, and, when perfectly liquid, the linseed oil, heated to about 400° Fahrenheit, is mixed with it, and then the oil of turpentine is added. It is also possible to melt the copal in boiling oil, and then bring the mixture to the proper consistency by the addition of the

oil of turpentine, but in this process the oil is always in a measure burnt, and the varnish is more colored, and dries slower.

In the manufacture, care must be taken that the resins are of the same fusible quality, since if a portion is melted, and the heat be long continued, the color will be higher than it should. The liquid copal does not combine with the oil, but simply mixes mechanically with it, having its particles separated, so that it can mix with the oil of turpentine, which should be added slowly, so that the mixture shall take place by degrees.

The difficulties in the manufacture of varnish are not bringing the resins to a perfectly liquid condition; next, adding the oil either too cold or too rapidly, so as to cool the liquid resin too fast; allowing the mixture to become too cold before adding the oil of turpentine, or adding this last too rapidly; or having the oil too hot, when, if the resin has not been heated long enough, a violent ebullition is produced, which is dangerous, as it is apt to run over into the fire, and cause a destruction of the entire building.

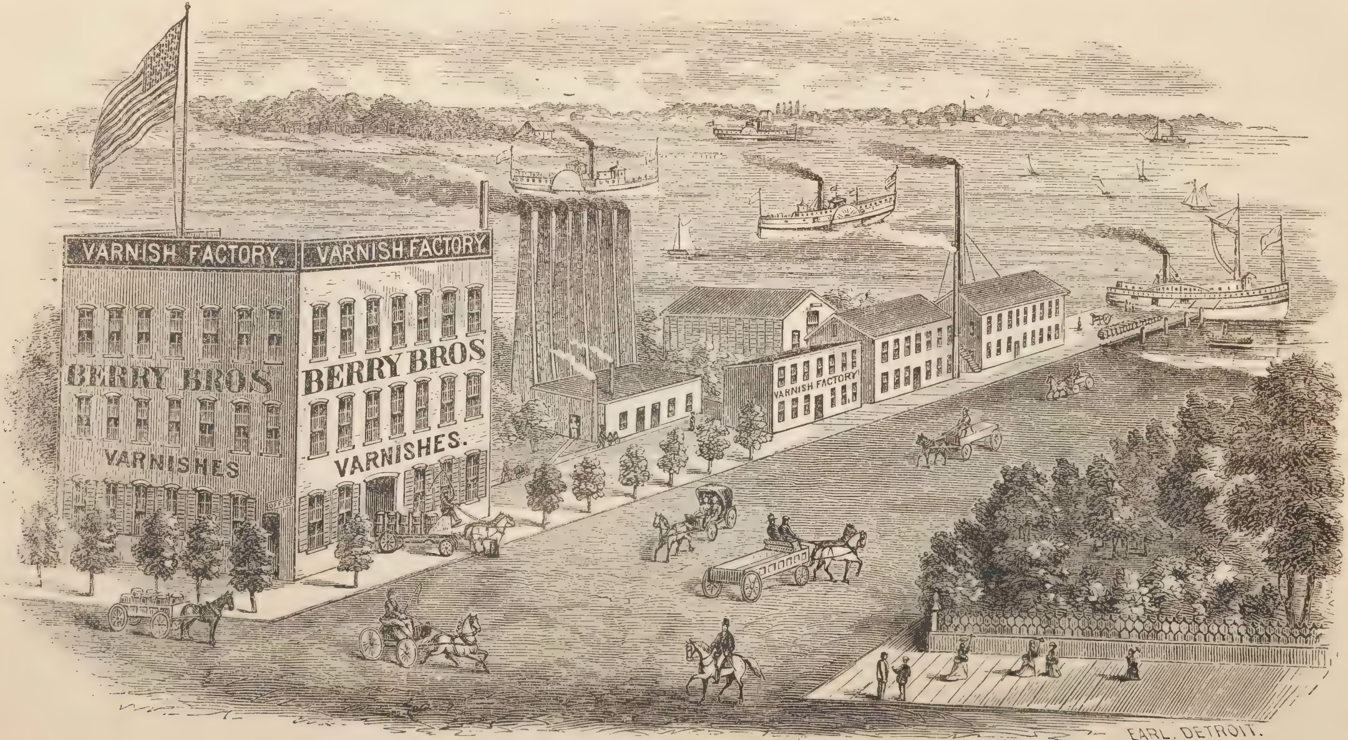
In the manufacture of varnishes the variations of the weather have to be observed, since when it is damp they absorb sufficient moisture to greatly impair their transparency.

Beside these staple kinds of varnish, other varieties are produced, which are used for special purposes, but do not enter sufficiently into the consumption to be treated of here.

In the United States the consumption of varnish is very large, and has greatly increased during the last ten years, from the greater number of purposes to which it is applied, and from the greater increase of wealth, which enlarges the demand for the articles of domestic luxury. The taste, too, for the use of natural woods in our houses and furniture, and the consequent discarding of the use of paint, have had much to do with increasing the consumption of varnish.

Among the manufacturers of varnish in this country, the leading house, at least in the Northwest, if not in the entire Union, is the house of Messrs. Berry Brothers, in Detroit, Michigan. These gentlemen commenced the business in 1858, and were the pioneers in that section of country. At the time they began, there were only two manufacturers of varnish west of New York. In this business the extent of the operations of any one house is of necessity limited, on account of the numbers engaged in the manufacture, and the facility with which varnish can be made.

Messrs. Berry Brothers consume daily in their business about



MANUFACTORY AND WAREROOMS OF BERRY BROS., DETROIT, MICH.

eighteen hundred pounds of gum-copal and shellac, and eight hundred gallons of spirits of turpentine, linseed oil, and alcohol, producing, with other ingredients of less consequence, one thousand gallons daily of varnishes and japans, ranging in price from eighty cents to six dollars a gallon. This work is done by seven men; while in the department of their business devoted to the packing, sale, and shipment of their goods, seventeen persons are employed.

The following list of thirty-six varieties of varnish and japan produced by this house will show to how many special uses varnish is put, and will indicate the increase of their business, owing to the established reputation of the goods they make: Zanzibar polishing, for pianos, etc.; light scraping; Zanzibar flowing; extra flowing; number one flowing; rubbing; number one turpentine furniture; number one benzine furniture; number two turpentine furniture; number two benzine furniture; light oil finish; dark oil finish; white shellac; orange shellac; turpentine asphaltum; benzine;* turpentine japan· benzine japan; furniture oil; spirits shellac; clear trunk; black trunk; number one pail and tub; number two pail and tub; extra damar; number one damar; mastic varnish for pictures; zinc dryer; English elastic wearing body varnish; wearing body; light rubbing; number one gearing, quick drying; number one gearing, medium drying; number one coach, quick drying; coach japan; japan, gold size.

* Asphaltum.

MANUFACTURE OF FLOUR.

ANALYSIS OF A GRAIN OF WHEAT. — GLUTEN THE NUTRITIOUS ELEMENT. — WHERE THE BEST WHEAT IS GROWN. — THE RICHMOND BRAND OF FLOUR. — WHEAT IN NEW ENGLAND, PENNSYLVANIA, OHIO, ETC. — THE ANNUAL PRODUCT. — THE EXPORT. — TO MARKET AND MILL. — THE PROCESS OF MANUFACTURE. — SOUND AND "WEEDY" FLOUR. — TECHNICAL TERMS.

When a grain of wheat is cut across the middle, and examined under a glass, the central parts are found to be composed of a white substance. If the grain is dry, this interior readily becomes a pearly powder. Near the outside of the kernel the texture is more compact, and at the surface it becomes horny. This added firmness of the grain is produced by the increasing quantity of gluten, as the analysis advances from centre to circumference. It is necessary to understand this composition of wheat in order to know what makes the best flour, and how the inferior grades of the same article are composed. It is the gluten that gives flour its strongest constituents; that is to say, the nature of gluten is similar to that of meat or cheese, while the nutritive power of starch alone is no more than that of rice. In short, rice flour is wheat flour with gluten left out. In wheat flour the proportion of gluten to starch is as one to five, and in some cases, as one to four. The greater or less quantity of gluten in flour renders it more or less nutritious; that is, the flour is more or less effective according to its quantity of gluten. That wheat which is grown in a dry and clear atmosphere, and on a fresh and strong soil, contains the greatest quantity of gluten. The best of our wheats are those raised in California and Oregon. The summer of these states is long and uniform, and allows the grain to ripen perfectly. Such is the freedom of these localities from moisture that the grain is left in the field, piled in bags one upon another, and covered with a layer of straw, for several months after it is threshed. It

thus becomes perfectly ripe and dry, and able to bear transportation across the equator without injury to its quality.

In appearance this wheat is plump, smooth, and of a pale amber color, like that of a delicately baked loaf of bread. It is sown in the fall, about the time of the first hard frosts. It generally springs a few inches above the ground, and in that condition goes through the winter, making but little advance, and starting into luxuriant and rapid growth in April. The wheat harvest, in countries where wheat is the staple, commences in the middle of May and June, and lasts about thirty days before the grain becomes so ripe as to shell in handling. The chief characteristic of wheat that grows in dry climates is, that the gluten becomes perfectly dry and hard; that is, the grain is thoroughly ripe, and the gluten, which forms the sticky part of the flour, will bear transportation to great distances, and keeping for many months, yet be as good as it was when first harvested. The Richmond flours were for a long time noted for this quality, and until the great development of the west, Richmond was the leading city in the production of the first grades of flour. Their wheats grew in West Virginia, East Tennessee, Western North Carolina, and Georgia. The greater portion of Richmond flour is used in Cuba and the South American cities, because it bears transportation and keeps in hot climates for a year or two without injury, while the western wheats must be kept cool, and should be consumed within a few months after they are ground.

At present the greater part of this commodity is produced in those states which border the great western rivers. The amount of wheat grown in New England will not bread its population a month. The western part of New York is a fine wheat locality, and Genesee flour long had celebrity, but so great is the population of the Empire State that all the wheat grown in it would not feed its population more than half a year. The State of Pennsylvania is, in this respect, a pattern, blending consumption with production in equal proportion. The Keystone State supplies itself with flour, but has no surplus. Until within a few years Ohio has furnished two or three million bushels surplus; but her production has fallen off very much, until she consumes nearly all the wheat grown within her limits. When we go west of the Wabash, we come to states that produce a very large surplus. The wheat crops of Illinois, Iowa, and Minnesota frequently reach the immense product of twenty million bushels, and the wheat crop of

California ranges from eighteen to twenty-two millions. The grain of the Pacific slope, after supplying its own population, is almost wholly exported to Liverpool, but the grain of the western states is stored in the great western cities of Milwaukee, Chicago, St. Louis, and Toledo. The handling of these great quantities of wheat is performed by means of elevators, which it may be interesting and pertinent to describe.

From the field where the wheat is threshed it is carried in bags to the nearest railroad station, and poured into cars made expressly for transporting it, whose capacity is about three hundred bushels apiece. Thence it is rolled to the elevator, a building six or seven stories high, where it is inspected by an officer appointed for the purpose, and classed in its appropriate grade. Of this more hereafter. The doors of the cars are then rolled back, and the wheat which pressed against them falls into a large hopper beneath. Two or three stout laborers with grain shovels step into the car, and in a few minutes its contents are all transferred to the hopper below. This receptacle has a bottom sloping to one side, through which, over a pulley, a large band passes, which goes over another pulley in the top of an elevator. This band has brackets of tin fastened on it which contain about half a bushel apiece. As the band passes through the hopper these buckets fill themselves, and are drawn very rapidly up the elevator, discharging the grain into the loft above as fast as it can be shovelled into the hopper from the car. From the buckets it passes into a large receptacle or bin, which contains from two to three tons. Here it is weighed, and thence conducted through spouts to other bins, grades of the same kind being kept in the same receptacle. These bins are twenty or thirty feet square and fifty or sixty feet deep. From these bins spouts go down to the holds of vessels or to cars, and the wheat descends with great rapidity, so that the hold of a vessel of two hundred and fifty tons will be filled in two hours.

As we have remarked, before the wheat is removed from the car in which it is transported to the elevator, it is inspected by the proper officer. He divides it into four grades. That which is sound, plump, and well cleaned, goes into the first grade. The second grade is sound and plump, but not so clean as the first. In the third grade is classed wheat inferior or dirty, but not so badly damaged as to render it unfit for flouring, nor weighing less than fifty-five pounds. All wheat so badly damaged as, from any cause, to render it unfit for number three, is put into a fourth grade,

and termed "rejected." From the elevator the wheat is carried by ship or by rail to the various establishments where it is made into flour.

Most of the southern wheat is brought to Richmond and Baltimore, where it is ground into flour. Along the banks of the James River there are a number of large flouring establishments. Baltimore is another large flour centre. About one half of the western wheat is converted into flour near where it grew, and much of the other half comes east by lake and rail to be ground at Toledo, Cleveland, Detroit, Buffalo, Ogdensburg, and Oswego. Several million bushels of wheat are made into flour in the cities along the Erie Canal, and especially at Rochester. For instance, in 1869 Chicago sent east nearly three million barrels of flour, at the same time she shipped eight million bushels of wheat to Buffalo.

The development of railroads and steamboats has dispensed almost entirely with the use of bags in handling the wheat crop. The car or vessel containing wheat passes at once to the flouring mill, where the grain is lifted directly by means of an elevator into the loft of the mill. From this loft it is conducted through a tube to the spout, whence it pours into the hopper, where it is ground. At the end of this spout is a fanning-wheel, which throws a strong blast of air up through the spout, thus permitting only the heavy and sound grain to fall into the hopper. All chaff and light grain is blown up outside the spout and falls on the floor. By shortening this tube at its lower section the grain can be thoroughly winnowed, while by lengthening it the lighter grain will fall with the heavy into the hopper.

The stones used in grinding are called French burr stones, though they are found in Arkansas, and in other parts of this country. In some flouring mills steel-faced stones are used, but they make a flour inferior to that produced by the French burr. From the receptacle into which the flour falls from the stones it is carried at once to the bolt. This is a large cylinder, usually eight sided, covered with bolting cloth, and made to revolve. It is set at an angle so that at the upper end of the bolt only the finest of the flour passes through the cloth. At the middle more of the bran goes through with the flour, and is therefore termed middlings, and at the lower end of the bolt the bran falls through. After passing through the bolt the flour is carried by small elevators into the meal room, and falls from quite a height on a clean floor, where it is allowed to cool. It is then packed in barrels and shipped.

One hundred and ninety-six pounds is put in each barrel. If the flour is packed before it has had time to cool perfectly its quality is materially injured.

The flour made from the best California or amber Michigan wheat is of a very delicate cream tint, just turned from white, and if pressed firmly in the hand will remain in a ball, retaining the impress of the fingers. When spread evenly in the hand, and smoothed with an ivory spatula, it presents a uniform and polished surface.

From the mill the flour is shipped to various points, where it is inspected by officers appointed for the purpose. If it is of full weight, strictly sound, and free from any and every defect or fault causing either smell or taste, it is called "sound," and is branded by the inspector according to its grade. Standard samples of flour are used for the inspector to work to, and the flour is branded "extra" and "superfine," according to its correspondence with these samples; they are in the hands of the flour inspection committee, and also with the secretary of the board of trade. These officers are required to see that the rules established for the inspection of flour are not varied from by the inspector. Flour made from wheat that has been mixed with a noxious weed, imparting to it an unpleasant smell, is termed weedy. This weed, it is supposed, will "cook out," so as not to be tasted in the bread; but such flour is inferior, and can never be formed into loaves of first quality in appearance, nutrition, or flavor. All flour not "sound," or "weedy," whether its defects are derived from the condition of the wheat, or have originated in the flour, is termed "unsound." The inspectors note the character of the unsoundness as *musty*, *hard sour*, *soft sour*, *slightly unsound*, the latter indicating that, for immediate use, the flour is but slightly depreciated in value. No "unsound," "weedy," or "light weight" flour can be stencilled in any way by the inspectors. Success in the flouring business depends on the judgment with which purchases of wheat are made, and the skill with which low grades of grain are cleaned and mixed with the better sorts so as to produce fair flour.

SILVER MINING.

GENERAL REMARKS. — THE PROSPECTOR. — HIS HAUNTS IN AND AMONG THE ROCKY MOUNTAINS. — THE COMSTOCK MINE IN NEVADA. — THE GOULD AND CURRY. — THE YELLOW JACKET. — THE GREAT YIELD OF THESE MINES. — THE PROCESS OF MINING. — PRODUCT OF CALIFORNIA.

Previous to 1860 it would have been improper to speak of the extraction of silver ores from veins, and the reduction of such ores to bullion, as an important industry. It was possible to extract a few ounces of silver from a ton of almost any of our galena ores. A mine in Southampton had yielded some silver in combination with lead. Another mine in Davidson County, N. C., had been actively worked for argentiferous galena. But ninety-nine silver dollars out of every hundred in circulation had come from Mexico or from Peru. A little silver had been found in the gold of California, but so little as to be held as an alloy of the more precious metal.

From 1850 to 1860 the mountains, and gorges, and gulches, and flats, and sinks of that wild region in the far west were scrutinized, as no other part of the world ever was before, by an army of prospectors. As this remarkable class of men have done so much, and are still so active in developing the silver interest of this country, they deserve more than a passing reference. A prospector is a quiet, silent, hardy man, whose costume is a flannel shirt and coarse pants, with the bottoms rammed into his boot tops. He wears a revolver strapped over his hip, a knife in the same belt, and carries a pick across his shoulders. Somewhere on his person he carries a little brass blowpipe. When he starts out, he flings a fifty-pound bag of flour across the back of his little bony, hardy mule. Thus equipped, he is ready for a journey of a thousand miles over a trackless waste. No cañon so lonely and

remote as to escape his notice, no out-crop of rock so grim and inaccessible as to baffle his enterprise. He wanders from hill to hill, and from ledge to ledge, picking out specimens, crushing them to notice the lustre of the fracture, and melting a little of the rock on a nub of charcoal with his blowpipe.

Long practice, and the pointing of sharpened faculties to one and only one end, makes him an exquisite judge in mineralogy. He knows nothing of trilobite, and eocene, and lias; but, from the glitter on the face of a broken stone, he knows whether there is silver in it, and from blowpipe analysis he can tell about how much per ton. For nearly twenty years an army of these indefatigable pioneers has been ranging over the grim and giant mountain ranges that divide the Mississippi Valley from the Pacific Ocean. They have wandered far south, following up the Gila into grim wastes and over the blazing sands of Arizona. They have scaled mountain peak after mountain peak, till the valley of the Saskatchawan, wide and fair, lay spread before them. They have drank water that was bitter with alkali, and rode day in and day out across saharas, penetrating beyond the sinks of the Humboldt, across Promontory Mountain to red dome peaks, past the Three Buttes to where the Wasach peaks tower savage and snow-clad over the bitter waters and sage brush flats of Utah. When a ledge or lode is found to hold a precious metal, it is traced as far as the nature of the formation will permit, and the right by discovery is set up by means of stakes, and the strip of mining property thus rudely bounded is called a claim.

In 1858–9 a small party of these prospectors worked up Six-mile Cañon, in the Washoe country, on the eastern foot-hills of the Sierra. James Fennimore, or Phinney, and Henry Comstock filed a claim to a mine of rich silver sulphurets mixed with free gold. Phinney sold out to his partner for a pinch of gold dust, and Comstock parted with his interest soon after, but not without giving his name to the most wonderful silver mine on the face of this planet. As soon as the marvellous wealth of this lode was known, and began to be developed, the silver mining interest took form, and became noteworthy as a source of great national wealth. This lode is situate in Storey County, Nevada, twenty-five miles from the western border of the state, and twenty miles from a little station of the Union Pacific Railroad, at a station called Reno, on the Truckee River. It is found cropping out along the eastern

DISCOVERY OF SILVER IN PERU.

INTERIOR OF A SILVER MINE.

slope of Mount Davidson, a lofty eminence in the Washoe range, which forms a lower spur of the main sierra. This range is extremely dry and barren, containing but little water or grass, and at present no timber at all, the few scrub pines that straggled over its rocky sides having been cut long ago.

A very valuable slice of the Comstock lode, by transfers in San Francisco, came into the hands of Messrs. Gould & Curry, men of capital; who fell to with great intelligence and vigor, and no stint of means, to develop the best silver mine in the world. The principal or mother vein of the Comstock ranges nearly north and south ; its average width is fifty feet, being in the thickest two hundred, and at the thinnest twenty feet, with a tendency to greater thickness and richness as the vein sinks in the mountain side.

There is perhaps no instance so striking of the promptness and daring with which American capitalists launch their money into an enterprise in which they have confidence, as the development of this Comstock lode. In 1861 this lode was a wall of black sulphuret, bedded in primeval granite and quartz, on the steep slope of a lonely and barren mountain, two hundred miles from roads and shops, and wheat fields parted from them by the gorges and snowy peaks of the sierra. Four years after a city of twenty thousand people was planted on that wild declivity, nearly two and a half millions in assessments had been paid to develop the mines. On the 1st of September, 1865, the leading mines on the lode had yielded as follows : —

Gould & Curry, ...	$14,000,000
Ophir, ...	7,000,000
Savage, ...	3,647,764
Imperial, ...	2,500,000
Yellow Jacket, ...	1,891,916
Belcher, ...	1,462,005
Total, ...	$30,501,685

The total number of tons extracted by Gould & Curry in these four years was one hundred and seventy-three thousand, and the bullion produced amounted to three hundred tons. The average cost of taking the ore from the mine was ten dollars per ton, and the average yield of all ores per ton was fifty dollars.

The Yellow Jacket, a very valuable mine on the same lode, made the following report for the year ending July 1, 1866 : —

218 tons first class ore yielded, per ton, .	$172.05
53,307 " second " " " . .	31.00
1,479 " third " " " . .	3.26
Average of all ore worked, per ton, . .	32.51
Gross product of bullion, . . .	1,690,394

The express company of Wells, Fargo & Co. took by far the greater part of the Nevada bullion to San Francisco between 1861 and 1865, and their books show interesting figures : —

In 1861 their receipts from Nevada were .	$2,275,276
In 1862 " " " " " .	6,247,074
In 1863 " " " " " .	12,486,238
In 1864 " " " " " .	15,795,585
In 1865 " " " " " .	15,184,877

In and near Virginia City, which stands directly over the Comstock lode, there were four years ago sixty-two mills for stamping and amalgamating ore ; they showed in all twelve hundred and twenty-six stamps and nine hundred and nineteen amalgamating pans, and they were working per month fifty-three thousand seven hundred and eighty-seven tons of ore.

The ore, as it comes from the mine, is a dark, lustrous rock, showing some free gold in pockets ; but the chief value is in the sulphuret, as it is called. There are black and gray sulphurets of silver, with some free or native silver. Combined with this ore are some baser metals, as sulphurets of antimony, lead, iron, and copper. By simply crushing and amalgamating the pulp with mercury, on an average eighty per cent. of all the precious metal in the Comstock ores can be extracted. For the first two or three years after they were opened the silver ores from this ledge yielded from one to three hundred dollars per ton, the average of all worked being over one hundred and fifty dollars, and some selected lots ranged from five hundred to three thousand dollars per ton. These rich ores were sold to San Francisco dealers in metalliferous ores, and most of them were shipped to the great reduction works at Swansea, England.

The crushing and extraction of silver ores, as practised in Ne-

vada, Idaho, and Montana, is not difficult or complicated. Eighty per cent. of these ores is taken out by a system not hard to be understood; as to the remaining twenty per cent., it is not taken out in the vicinity of the mines. This leaves a vast accumulation of "tailings," or crushed rock, in which there is some silver, and the question whether it will pay to get it out, must depend on the nearness and cheapness of fuel, on the skill that can be commanded on the spot, and on the supply of richer ores available and as yet unhandled. Three fourths of the precious metal is taken from ore as follows: —

The rock is taken to stamp mills, which consist of iron cylinders, weighing, say one hundred pounds, raised about a foot from an anvil or die, and allowed to fall on the ore as it is pushed under the point where the blow falls. This pounding produces, after some hours, a paste or pulp of the ore as water is freely admitted into the mortar. Then the pulp flows to a metallic pan with grooves in its bottom, which grooves are loaded with quicksilver; above the grooves there is a false bottom of iron, in ridges against which the pulp is ground by arms that revolve on an axis at the centre. This grinding and revolving has a tendency to bring every part of the pulp or argentiferous mud in contact with the mercury. The nature of mercury is to attract or absorb the two precious metals, thus forming an amalgam or mercurial paste. Straining through buckskin parts the precious metals from the mercury, and this can be used in the amalgamating pans to absorb more silver and gold. The product obtained by straining is brittle and sand-like, but heat melts it down to a brick or bar of bullion; and the Bank of California, and many private bankers, give gold and silver coin for these bricks.

From 1859 to 1866 the total product of the mines on the Comstock lode was about seventy million dollars. This brilliant success has stirred up wonderful enterprise in all parts of the rock mountain and sierra region. It is found that, while the Comstock is the thickest and the longest vein ever developed, there are thousands of lodes two feet and three feet thick, and eighteen inches thick, that yield rich ores. The mountains of Colorado are full of such veins. Idaho and Montana repeat the history of Nevada and Virginia City on a smaller scale; and of late the Wasatch range, that towers above Salt Lake Valley, has been found rich in silver-bearing lodes.

In general the more westerly mines, as those of Nevada and

Idaho, have yielded their silver with least expense. The ores of the Rocky Mountains proper — as, for instance, in the Colorado mines — are sufficiently rich, but they consist of a perplexing combination of uncommon and refractory metals. Some Colorado ores contain, besides the two precious metals, copper, bismuth, nickel, antimony, iridium, rhodium, lead, and tin. It requires six or seven successive and expensive processes to free the silver from these complicated connections. But every year our metallurgists are gaining ground in their struggle with refractory ores. For example, the Cariboo mines, in Colorado, have been so successfully worked the past year that, if the product were equally divided between all the inhabitants of the district, each would have six hundred dollars. But counting all the industry of the hardy and ill-requited prospectors described, and the loss from valuable tailings that as yet we cannot economically save, it is doubtful whether any industry gives such irregular and unsatisfactory returns as silver mining. A few it has made very rich, but the many it rewards poorly, yet lures them by deceptive appearances to a longer investment of time and a larger outlay of capital.

Yet so extensive are the mineral lands of this continent, and so rich are many of the ledges that are opened, that the sum total of silver bullion, or bullion in which silver is the chief element of value, sums up in impressive figures. There is much discrepancy and difficulty in estimating how much may be quietly carried away in the purses of modest placer miners who seldom report their luck, but the opinion of those who have the best opportunities of knowing is that our annual product is one hundred millions.

SAFES AND SAFETY LOCKS.

THE MODERN INCREASE OF WEALTH. — ITS CAUSES AND ITS EFFECTS. — CHANGE IN THE NATURE OF WEALTH. — SAFES IN ANTIQUITY. — AMONG THE EGYPTIANS. — THE GREEKS. — THE ROMANS. — IN THE MIDDLE AGES. — ROB ROY'S SAFE. — FIRST IMPORTATION OF SAFES. — FIRST FIRE-PROOF SAFES. — VARIOUS METHODS PROPOSED. — STEAM SAFES. — LOCKS. — MODERN INVENTION OF. — LOCK-PICKING A STUDY. — CHARACTER OF AMERICAN SAFES. — THE HALL SAFE AND LOCK COMPANY OF CINCINNATI. — EXTENT OF THEIR BUSINESS. — METHOD USED IN CONSTRUCTING THEIR SAFES. — PUBLIC APPRECIATION OF THEM. — BIOGRAPHICAL NOTES OF MR. JOSEPH L. HALL.

THE increase of wealth, produced by the industrial advance of the present century, has made its preservation a more universal subject of interest than ever before in the world. While the wealth of the community has largely increased, the holders of individual wealth have multiplied in a much greater ratio. The greater opportunities for individual success, consequent upon the removal of so many of the old obstacles to individual exertion, together with the new spirit of enterprise which has arisen as a result of the greater freedom of thought which the speculation of the last century inaugurated, have resulted in producing a more general diffusion of riches than was prevalent a century or two ago.

The rich men of a century ago were few in number, and were generally such from inheritance, from the workings of legislative injunctions, from government patronage, or some similar cause. With the large mass of the community a moderate subsistence, gained by daily toil, was considered all they could expect, and any discontent with this was repressed by the moralists as an unjustifiable discontent with the wise decrees of Providence, which had given them the dependent position they should hold.

To-day, however, the large majority of our rich men have made themselves so by the exercise of enterprise, foresight, or a wise

comprehension of the opportunities around them ; while the number of these has largely increased, and energy, enterprise, and an ambition to better one's condition are the lessons taught by those who assume to teach the needed lessons of the time.

At the same time, also, a great change has come over the form and the evidences of the wealth we possess. In ancient times the chief riches, independently of real estate, consisted in the accumulation of the precious metals, or of jewels, while in the present time these are the smallest part of our personal property, which consists of paper representatives of value, stocks, bonds, notes of all kinds. In consequence, formerly the transportation or storage of a large amount of wealth was difficult and laborious, whereas now a man can carry in his pocket evidences of values which formerly required a train of wagons to move.

In Egypt, at the earliest period of history, the organization of government had attained a point of perfection which made its treasury an important interest. The stores of money gathered from the heavy taxes laid upon the industry of the country were carefully guarded in securely-built treasure-houses, fastened with locks of elaborate construction.

Wilkinson, in his *Manners and Customs of the Ancient Egyptians,* describes a key made of iron which he found in the ruins of Thebes, and which had a shank five inches long, the handle being made by a loop at one end, while the other was turned at a right angle, to form the operative part of the key, which was furnished with three teeth, or points, to fit into corresponding cavities in the lock. Other keys have also been found and described, from which it appears that the Egyptians were acquainted, at this very early period, with some of the principles which have been supposed to be distinctive in modern improvements in locks ; for example, that of tumblers, which hold the bolt fast until they are first moved by the key.

In fact, rudely constructed locks upon this principle were also in use by many of the nations in Europe during the middle ages, though it has only recently been made use of by our modern lockmakers.

In the Bible, in *Judges* iii. 23, Ehud is spoken of as locking a door with a key, and in the subsequent verses the use of another key to open the door is mentioned.

Homer, in the *Odyssey,* speaks of Penelope as opening a wardrobe with a brazen key, made very crooked, and provided with a handle of ivory.

The discoveries in Herculaneum and Pompeii have shown that, among the Romans, locks of intricate workmanship were in ordinary use, and in Great Britain keys have been found which dated back to the Roman occupation of that country.

Among the Chinese lock-making has for a long time been well understood, and locks constructed upon the principle of the famous Bramah lock, which was invented in England in 1784, have been there made of wood from early times. In these the tumblers are made of different lengths, intended to fit exactly the sizes of the wards in the keys.

During the middle ages chests for the safe keeping of valuables were ordinary articles of furniture in houses, and were made very elaborately, strengthened with iron-work of various kinds, and furnished with locks which were frequently decorated in very artistic ways. These chests, which were really the safes of that time, were protected from being broken open by bands of iron. The burglar's cunning had not at that time reached the perfection it now has, and a modern "cracksman" would laugh at the provisions made then for security. Nor had the burglars of that time the education in their art which those of the present time have, so that doubtless the security was nearly satisfactory.

The modern spirit of enterprise had not yet arisen to inaugurate the struggle for the mastery between the "cracksmen" and the safe-inventors, and the contest was carried on upon a different plan. The wealthy then depended more upon the impregnable character of their houses than upon the strength of the chests within them.

With the advent, however, of the joint-stock system, the introduction of paper money, and the commencement of our modern commercial activity, wealth began to assume a more portable form, and large values began to be possible in conveniently small packages.

In Sir Walter Scott's *Rob Roy* an admirable instance is given of the simplicity of methods used in the rough and violent condition of society at that time, for the protection of valuables. Rob Roy shows a leathern bag, studded with large headed nails, which he had made for the protection of his treasure. The mouth of it was secured with a lock, and he was very proud of a contrivance introduced into it, by which a small concealed pistol would be discharged at any one who should tamper with it irregularly. It

had never occurred to him that the bag itself could be easily cut to pieces with a sharp knife, without in any way approaching the lock so as to discharge the pistol.

The incident, which is said to have been founded upon fact, shows how little accurate study had been given to their specialty by either the defenders or the burglars of valuables.

The oaken box defended by iron bars, which did duty for our present burglar-proof safes during the last century, began in the early part of this to be replaced by boxes covered entirely with iron. The Hall Safe and Lock Company, of Cincinnati, O., have a safe, formerly used by the Marietta Bank, and made in New York in 1807, which is constructed of oak plank, two inches in thickness, bound together by iron straps, and thickly studded with small nails. It is "secured" by an ordinary hasp and padlock.

About the year 1820 attention was turned towards making fire-proof chests for valuables. With the introduction of paper representatives of wealth, their destruction by fire became possible. A considerable amount in any of the precious metals, if exposed to a conflagration, even though it was melted, could be recovered without great loss from the ruins, but there was no such opportunity with paper.

The first attempts to make fire-proof safes appear to have been made in France. The safes were made with double walls, the space between them being filled with a non-conducting substance, a composition. The idea was quickly taken up in the United States, and in 1843 the first patent was issued to Daniel Fitzgerald for making fire-proof safes. This was afterwards assigned to B. J. Wilder, and the safes made thereunder are known as the "Wilder patent."

In these the space between the walls of the safe was left vacant, dependence being had on the non-conducting properties for heat of the air thus enclosed to preserve the contents of the safe thus made. Other substances, which had also a high non-conducting power of heat, were proposed for the filling of the space left between the walls, and numerous patents were granted for various compounds.

The attention of inventors was the more directed towards this subject by the occurrence of extensive conflagrations, especially that of New York in 1835. Asbestos mixed with plaster of Paris, clay, alum, fire-clay, mica, and chalk, have each in turn been used with more or less effect, and in turn proclaimed as absolutely fire-proof.

The intense heat, however, to which safes are subjected, in many of the conflagrations, raising them frequently to a bright-red heat, and sometimes to a white heat, showed that none of these fillings were, as they claimed to be, absolutely fire-proof.

Another plan, patented by Professor A. K. Eaton, of New York, consisted in using pure alumina, which he prepared by a method of his own invention, that enabled him to obtain it cheaply, or mixed with fire-clay. He also introduced the idea of using steam as a non-conductor. Pure alumina, he found, was not as effective in withstanding heat as some mixture in which water was contained, either in combination as a paste, or in the form of crystallization. The theory of this mixture is, that when the safe is exposed to an intense heat, the water in the mixture is given out, and being converted into steam, absorbs the heat and prevents it from attacking the contents of the safe. Experiments showed that as long as any steam was produced, no excessive heat reached the articles contained in the safe. The chief objection, however, against the use of safes thus constructed, was the dampness caused by the mixture, and the mouldiness to which the contents of the safe were thus subjected.

The protection against burglars is, however, in these days the most important point in the building of safes. While the inventors of locks and safes have been engaged in devising new and ingenious methods of construction to attain this end, the burglars, on their part, have been equally laborious and shrewd in studying new methods for overcoming the new obstacles offered to their successful prosecution of their profession. The appliances of a first-class burglar are not complete, at the present day, unless he has an assortment of drills of all degrees of hardness, blow-pipes for taking the temper out of the steel plates, a supply of powder, nitro-glycerine, and fuses, wedges, files, and saws, together with a mirror for examining the interior of the locks, skeleton keys, and above all, a thorough experience as a practical mechanic, together with a full comprehension of the details and the theory of lock-making.

During this century great attention has been given both to lock-making and lock-picking. The first great improvement was the invention of the Bramah lock, so named from its inventor. This lock abandoned the use of wards, and other improvements introduced into it enabled it for a long time to retain its reputation as a lock which could not be picked. It was picked, however, in

1851, by Mr. Hobbs, by what is known as the tentative process. A lock of this make had been publicly displayed for years in the window of the office, with a reward of two hundred pounds to any one who would pick it. In the process Mr. Hobbs broke one of his instruments, and was therefore nineteen hours in succeeding, but he afterwards performed the same feat three times within an hour.

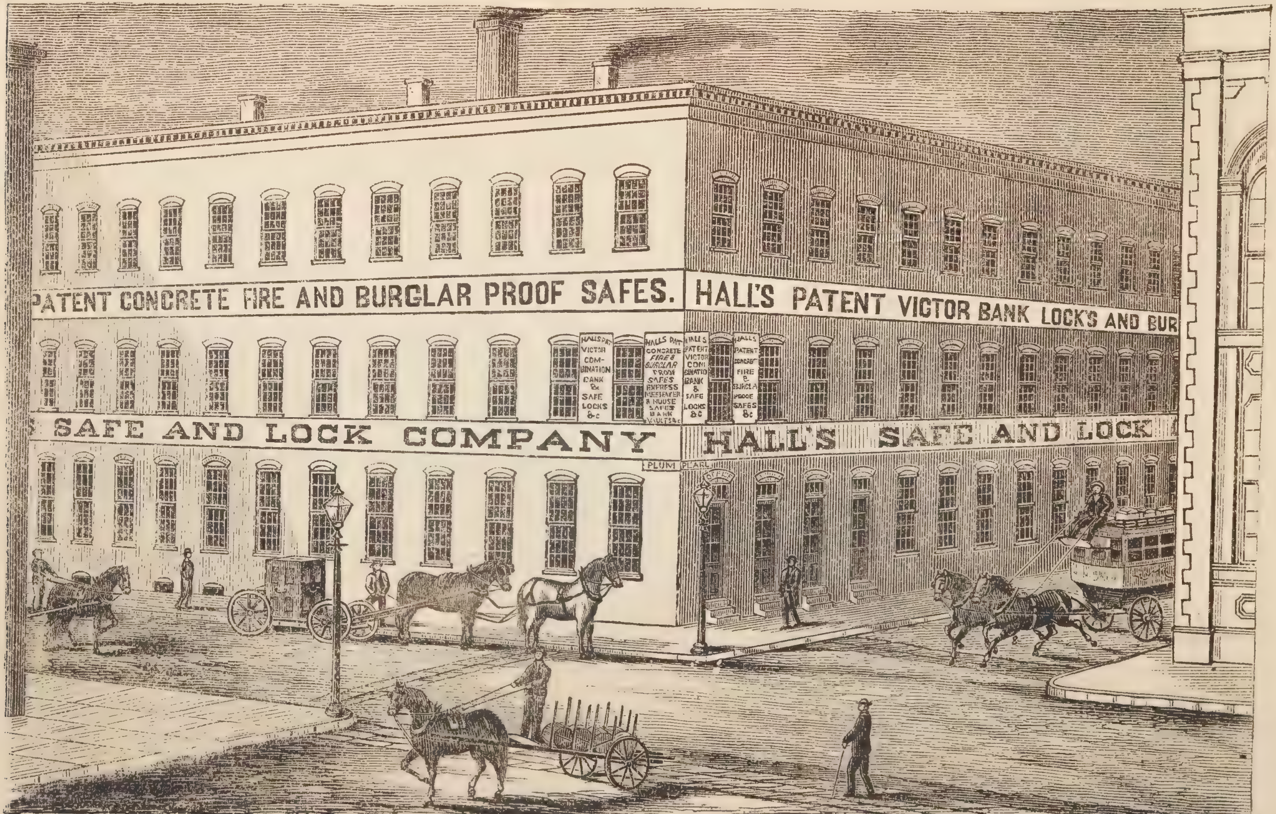
The next important lock invented was Chubbs's, which was produced in England in 1818. But this was also picked by Mr. Hobbs with ease. A lock made by Mr. Pyes was then, in the London Exhibition of 1851, offered by Mr. Hobbs, who challenged any one to pick it. This feat was accomplished, though not until 1855, by Mr. Linus Yale, Jr., of Philadelphia, by what he called the impression process.

In 1843 Mr. Linus Yale, the father of the gentleman last mentioned, patented a lock which was in its turn considered absolutely unpickable, until it was picked by his son.

The interest thus excited in the subject of safes and locks by the course of events, of which we have given this rapid sketch, has so stimulated the inventors of the United States that now the safes and locks of their manufacture stand confessedly at the head of this industry in the world. The testimony of Mr. E. B. Denison, the celebrated lock-maker of London, is conclusive upon this point. Speaking of them, he says they are "vastly superior to any we have ever seen made in England; and on the whole, the United States are evidently far ahead of us in the manufacture of both good and cheap locks."

Among the firms engaged in the United States in the manufacture of burglar and fire-proof safes and locks, the Hall Safe and Lock Company of Cincinnati, Ohio, stands preëminent. The founder of this company, Mr. Joseph L. Hall, established his business in Cincinnati in 1848.

From the commencement success crowned his efforts, and now, though the works are producing from fifteen to twenty safes a day, yet they are found inadequate to supply the demand for them, and are to be greatly enlarged. There is nothing strange in the increase of this demand, when it is remembered that in the course of their business career the Hall Safe and Lock Company have sold over fifty thousand of their safes, and have yet to learn of the first instance in which a safe of their manufacture has failed to prove itself, when tested, absolutely burglar or fire proof.



MANUFACTORY OF HALL'S SAFE AND LOCK COMPANY, CINCINNATI.

The method of construction used in these safes makes them impregnable to any appliance in use by the most expert burglars. The doors, which are generally the weak point of a safe, are constructed of plates, so dovetailed, and fitting correspondingly into the jambs, that the wedge, the most effective implement used by the burglar, is perfectly powerless against them, while the accuracy with which they fit offers no opportunity for any crevice into which nitro-glycerine, or any other explosive fluid, can be introduced.

The body of the safe being also constructed of alternate plates of iron, welded iron and steel, carbonized and decarbonized steel and crystal steel, fastened together by bolts from the inside, effectually prevents them from being forced by sledge-hammers, jimmies, jack-screws, or any other burglarious instrument. Their fire-proof qualities are also secured by a filling of Hall's patent concrete, which makes them absolutely proof against both fire and damp. In addition to the fire-proof filling, the safes made by this company are provided with Hall's patent combination locks, varied for each safe, many of which are supplied with an automatic rotary movement, and consequently operated without any arbor or spindle passing through the door into the lock, rendering it impossible to pick them by any process yet invented.

The many attempts which have been made to break down the reputation of these locks have only served to strengthen the good opinion in which they are held by those most interested, viz., the bankers of the country. The challenges and tests which have been made by expert lock-pickers, as a consequence of the superior claims made for Hall's patent locks, partake more of the character of romance than of a history of mechanics; and it is sufficient to say here, that every attempt made to pick or discredit them has signally failed, and that they are to-day superior to all other locks.

Justly, therefore, the Hall Safe and Lock Company claim that they produce safes which are absolutely fire and burglar proof, and their claim is supported by numerous testimonials from those who have used them, all over the country. As, with these merits, the organization of their manufactory and the magnitude of their operations enable them to carry on their business in the most economical manner, they are enabled to offer to the commercial world the most perfect security at the cheapest possible rate,

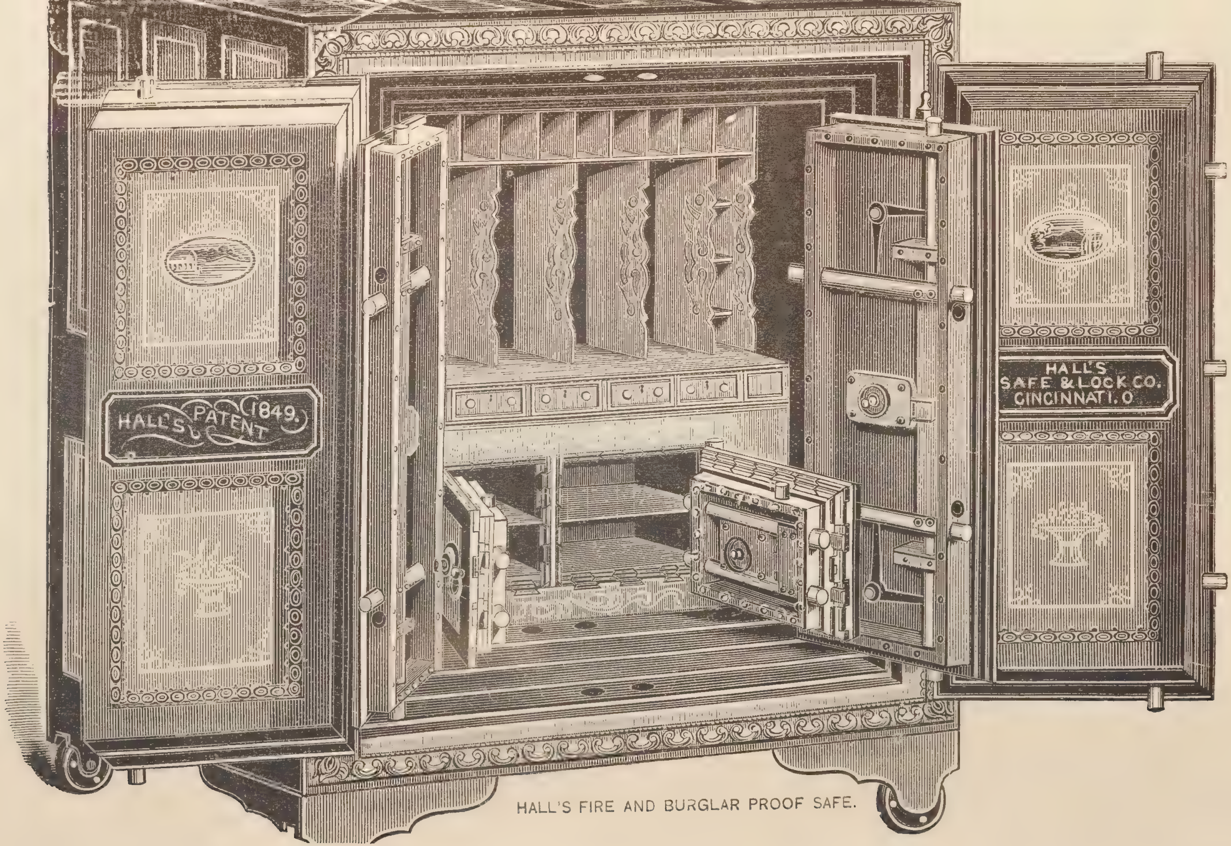
and the favor with which the public has received their wares shows that they have done this most effectively.

Mr. Joseph L. Hall, before referred to as the founder of the Hall Safe and Lock Company of Cincinnati, is a representative man among the manufacturers of the Great West. By perseverance, skill, and foresight he has, from a small and almost insignificant beginning, built up a business of colossal proportions. Mr. Hall was born in Salem County, N. J., in 1823. From there his father removed to Rochester, N. Y., and, in 1831, to Pittsburg, Pa., where, in 1846, he and his father commenced, in a small way, the manufacture of fire and burglar-proof safes and locks. In 1848 they removed the business to Cincinnati, and in a few years the father relinquished it into the hands of his son, who, associating with himself, from time to time, capitalists to prosecute his enterprises, continued the business, building it up, little by little, until it is now one of the heaviest branches of Cincinnati's extensive manufactures.

The biography of Mr. Hall, if fully written, would embrace a history of the rise of a great branch of industry from a small beginning until the time when it has reached, in the face of opposition and innumerable difficulties, a position commanding the respect of all.

Mr. Hall has not attained the position of a leading inventor and manufacturer without difficulty and labor. The ever-increasing dangers from fire, and the growing skill and audacity of burglars, have demanded constant and steady improvements in the construction of fire-proof safes and burglar-proof bank locks and vaults. To this end has the labor of his life been devoted, and as each successive improvement has been made and introduced by him, it has been assailed by rivals in different parts of the country. His fire-proof safes have been subjected to the most severe tests which the ingenuity of competitors could devise, and his locks have undergone every trial which is known to experts and burglars, but they have in every instance vindicated their invulnerability. While Mr. Hall has acted upon the defensive in all these trials, he has never yet retaliated by challenging the work of others, being content with the success which his own has enjoyed.

Mr. Hall is now in the prime of life, youthful in appearance, blessed with a strong constitution, sanguine temperament, and indomitable perseverance. Successful in business, he is possessed of a handsome competence gained by his own exertions.



HALL'S FIRE AND BURGLAR PROOF SAFE.

TRANSPORTING A SAFE.

In 1867 the business of Joseph L. Hall & Co. had grown to such proportions that it was deemed advisable to incorporate the house into a joint stock company, and the same was done under the name of the Hall Safe and Lock Company, with Mr. Hall as president and treasurer. Under his skilful management its business and reputation have been extended to every city in the Union, and to many places in Europe, and his name is known as a tower of strength wherever there are valuables to be secured against fire or burglars.

In the great fires which made memorable the years 1870–71, in Urbana, and Chicago, Ill., and the many towns in Michigan and Wisconsin which were almost totally destroyed by fire, the safes made under Mr. Hall's patents demonstrated their inestimable qualities. They were proven to be the only ones which were absolutely secure; and Mr. Hall's name is blessed by thousands who found, after the fires, that all the property they had in the world was that which had been preserved to them by his safes — a proud record for any man, but fairly earned by him in a life of incessant study and toil.

RAILROADS.

INAUGURATION OF THE RAILROAD ERA. — THE GROWTH OF THE RAILROAD. — THE INTRODUCTION OF THE RAILROAD IN THE UNITED STATES. — THE ORGANIZATION OF THE RAILROAD IN EUROPE AND THE UNITED STATES COMPARED. — THE BELGIAN SYSTEM. — THE RAILROAD SYSTEM OF ENGLAND, AND ITS RESULTS. — THE RAILROAD SYSTEM IN THE UNITED STATES. — COMBINATION VS. COMPETITION. — CONSOLIDATION AND MONOPOLY. — GOVERNMENT LAND GRANTS. — RAILROAD FINANCIERING. — THE FUTURE OF THE RAILROAD.

Inauguration of the Railroad Era.

Though the railroad has not been invented fifty years, and though within this short space of time it has become an absolute necessity for the transaction of the world's commerce, and one of the most important agencies in the activity of our modern life, still the world at large is hardly yet aware of its importance, of the dangers with which it threatens the modern democratic theory of social organization, nor of the best means which it is necessary to take in order to avert these, and reduce this threatening master of the commonwealth to its proper position as a servant of the public interest.

The railway was not complete until the idea of the locomotive, as an agent for the transportation on a level iron track, was practically realized. Before this was done, iron tramways had been for a long time used in England for facilitating the transportation of coal and other heavy products in mining districts; but the cars were all drawn by animal power. With the invention of the steam engine, it was suggested that stationary engines should be used for the purpose of dragging the loaded cars. With the first suggestion of a locomotive engine, the idea was considered absurd, and there were plenty of practical mechanics, who, having never seen such an innovation upon the established methods in practical use, were zealous in demonstrating by figures that it was impossible to make a locomotive engine which would be able to move itself, much more to drag any load after it. The driving-wheels, they said,

would simply slip over the track. To the mind, however, of George Stephenson, a coal miner of Northumberland, England, where this project for the transportation of coal was then exciting attention, such theoretical objections did not have sufficient weight. With a practical scepticism for all unverified hypotheses, at least in the domain of mechanics, he preferred to wait, before insisting positively upon his opinion, until the facts in the case were arrived at by actual experiment; and having by this simple method discovered that a locomotive was competent, not only to move itself, but also to drag a heavy load, he devoted himself to its practical demonstration, and thus earned for himself the well-deserved reputation as the originator of the modern railroad.

On the 6th day of October, 1829, he drove his little experimental locomotive, "The Rocket," from Manchester to Liverpool and back. This locomotive weighed only four tons and a quarter; but, besides showing it was really a locomotive engine, further astonished those interested in the experiment by travelling at the rate of thirty miles an hour. It was thus that the new era of transportation was inaugurated, and mankind acquired the ability to create an activity in the circulation of the products of industry and for travel, which has made possible the intensity of our modern life, and has done more in forty years to extend the feelings of mutual sympathy among distant nations, and to bind different peoples in the bonds of friendly interdependence, thus hastening the advent of the era of universal fellowship and aid, than all the forty centuries of the preceding historic times of civilization had done.

The Growth of the Railroad.

As an evidence of the results which the railroad has reached within the short forty years of its existence, the few following estimates are interesting. It has been computed that in 1870 there were about one hundred and twenty-five thousand miles of railroads constructed in the world, and that they had cost on an average about one hundred thousand dollars a mile for their construction and equipment, having thus led to the creation of an invested capital of some twelve thousand millions of dollars — an amount of wealth which can be represented in figures, but which is too vast to be grasped by the mind so as to be clearly comprehended.

In the United States, where the railroad has become more a necessary condition of existence than in any other country, with the exception, perhaps, of England, there were, in 1871, nearly

fifty thousand miles of railroads constructed, and the yearly increase had risen from an average of five hundred miles yearly some thirty years ago, or two thousand miles ten years ago, to twenty thousand miles in 1871. This being the estimated amount of miles which were during this year in course of construction, and which were to cause the expenditure of eight hundred millions of dollars.

The social, the financial, the commercial, and the industrial effects, which are the inevitable results of this new agent, may well excite the serious and careful attention of us all, and must, of course, alarm those who have no method by which to study such questions.

The Introduction of the Railroad in the United States.

At the same time that Stephenson was preparing his locomotive in England for its experimental trip, this country was agitated upon the question of internal improvements; and the Cumberland Turnpike being then the special application of the principle which was under discussion, the political parties were vehement in their declarations for and against the proposal to aid its construction by governmental assistance. To the debate upon this question Henry Clay, the great advocate of the system of internal improvements, brought all the force of his eloquence, and, by his advocacy of this special measure, hoped to have gained the eternal thanks of his countrymen; but now no one thinks of the Cumberland Turnpike, for the country has risen to the necessity of railroads to the Pacific, and it is not the union of the sections of the country divided by a range of mountains which demands the attention of Congress, but methods for uniting the East with Europe through the United States, and thus, for the first time in the history of the world, diverting the course of the world's commerce and exchange into a channel directly the opposite from that it has pursued from the earliest historic times.

The discussion concerning railroads in England had, however, excited an interest in their projection here. The tramway had been tried, and roads had been built at Quincy, Mass., for the purpose of carrying the blocks of granite from the quarries there, and also at Mauch Chunk, in Pennsylvania, for the transportation of coal from the mines. In both of these cases, however, animals were depended upon for the motive power used in the transportation.

The idea of a steam locomotive had, however, been suggested, and though its practicability had not yet been tested, and it was

as yet considered merely as a "splendid theory," still there were several persons in this country who felt confident of its eventual success.

The credit of first introducing the use of steam locomotives has been claimed for several different railroads in this country, but there is no doubt, though it is not generally known, that it belongs to the South Carolina Railroad, from Charleston to Hamburg in that state. This fact appears in a letter, from which the following quotation is taken, written by Mr. B. J. Howland, who was formerly a resident of Charleston, S. C., and who was one of the early directors of the road, and which was printed in the *Boston Daily Advertiser* for September 17, 1851. The letter is dated at New York, September 15, and, after alluding to some facts in the history of the South Carolina Railroad, continues as follows: "The facts I wish to state are four. First, that the South Carolina Railroad, from Charleston to Hamburg, was the first road that was *commenced* in this country, with a view to using *steam* instead of *animal* power.

"Second, that the *first* locomotive engine ever built in this country was built for and used on this road.

"Third, that it was the first road that carried the United States mail.

"Fourth, that when completed ready for use, which was on the 2d of October, 1833, it was the longest railroad in the *world.*

"The second is the only point upon which I desire to make any comment now, and I do this because this fact is not generally known, and when I had occasion, two years since, to state it, in conversation with Mr. Disturnell, the great railroad compiler, he said it could not be so; but I satisfied him, when I got home, by giving him the same extract I am about to give you. This extract is from a report made by Alexander Black, commissioner, to Elias Hovey, president of the road, dated May 1, 1833, in which he says, —

"'It is known to the board, but not to the public generally, that the engine now called the *Phœnix* was formerly the *Best Friend.* It was built according to the plan and under the personal direction of our talented and enterprising citizen, E. L. Miller, Esq. Its performance was tested on the *9th of December*, 1830, on which occasion it exhibited a power much beyond that stipulated for in the contract. At the time this engine was engaged, Mr. Miller led the van among the advocates of steam over horses or other power for railroads. Public opinion was at that time much divided on the

subject. The Baltimore and Ohio Company leaned in favor of horse power. Nothing daunted by the weight of their authority, Mr. Miller persevered, and with an unyielding fixedness of purpose, proposed to construct an engine on his own personal responsibility, equal to the best then in use in England. He succeeded; and to him belongs the honor of planning and constructing the first locomotive ever worked in the United States.'

"My attention was drawn to this subject by a notice in Saturday's *Boston Journal*, which stated that the first locomotive ever used in the United States is still in good running order on the Little Schuylkill Railroad. It was built in Liverpool, England, by Edward Bary.

"I am disposed to think this statement is not correct, and that Mr. Miller's engine was the first *used* in the country; at any rate it was the first ever *built* in the country, so we say and believe. I think that Mr. Miller's engine was built by the Messrs. Kemble, at the West Point Foundery."

From Mr. Black's report as commissioner, which is quoted from by Mr. Howland in the above letter, another singular fact may be culled, which is interesting as connected with the early history of the use of locomotives in this country. The "Best Friend" was accepted by the company, and performed with entire success until the next summer, without a single day's interruption, until "the negro, who acted as fireman, being incommoded by the unpleasant noise of the steam escaping through the safety-valve, ventured on the expedient of confining it by pressing the weight of his body on the lever-gauge of the safety-valve, which experiment resulted in the explosion of the boiler."

Whether the fireman was killed or not does not appear; but it was singular that it was a slave, who, from his ignorance of the nature of the engine he was ministering to, should have caused the first railroad explosion in the history of the country, and have thus injured the machine which was destined to be so instrumental in producing the social movement which led to the emancipation of his race.

The act of incorporation of the South Carolina Railroad was passed by the Congress of the state the 30th of January, 1828, and, as we have seen, the road was commenced in 1830, and finished in 1833, while the trial of the "Best Friend" was made on the 9th of December, 1830, while the "Rocket," Stephenson's first engine, made its experimental trip on the 6th of October,

1829, there being thus only thirteen months between the inauguration of the railway era of transportation in England and the United States.

The Organization of the Railroad in Europe and the United States compared.

With the exception of a few men in Europe and this country, who were practically interested in the introduction of the railroad, the importance of this new method of transportation, and the social and industrial effects it was destined to produce, were not clearly foreseen. In England and this country its development was left entirely to private enterprise, and the protection of the public interest could, it was hoped, be safely left to the action of competition. In the other countries of Europe, however, where the democratic idea of social organization had not yet reached so fully that phase of development where the assertion of individual liberty of action appears to be of paramount importance, as preparing men for the liberty of self-government, but where the centralization of monarchical rule was still strong, the governments saw the necessity for controlling this new element of social activity, and therefore the railroads were not allowed to pass into the hands of private corporations.

Most of the governments being, however, financially incapable of building the railroads as appendages to the prerogatives of the crown, this want of money, and the theory of constitutional monarchy which the revolutionary crisis of the last century had forced upon them, prevented them from building the railroads themselves; but in granting to corporate companies the right to construct them, they accompanied their charters with certain restrictions, and reserved to the government certain privileges and a right of partial supervision over their management.

In France, for example, the title of the companies to the railroads built by them is limited to ninety years, while the companies agree to carry the mails free, and to transport soldiers and munitions of war, when necessary, at cheap rates, and also to surrender the road, with its equipment and improvements, into the hands of the government at the expiration of their charter. Besides this, the government also retains the supervision of rates charged the public for freight and travel, and the right to lower them should the profits of the company be too great. Upon these terms the government lent its credit to the companies, and guaranteed them

that no charter should be granted to any other competing companies whose lines should be so situated as to lessen their business.

The governments of Austria, Prussia, and the other nations of Europe, have made similar arrangements for the introduction of the railroads in their territory, differing in special details, but all based upon the same general principles. The governments in all cases reserving the right of exercising a certain control over the rates charged by the roads, obtaining certain privileges, granting the charters only for a certain specified term of years, after which the roads revert to the governments, lending the credit of the governments to a certain amount to the roads to aid in their construction, and guaranteeing to protect them from competition.

The Belgian System.

In Belgium alone of the continental nations was a different policy pursued. King Leopold, who at that time was on the Belgian throne, appears to have been the ruler in Europe who best comprehended the exigencies of the new method of transportation, and saw the necessity for retaining, by some method of organization, a control over the possible future power which it might develop. The Belgian government, therefore, proposed to construct the railroads, and to operate them in the public interest. Very soon, however, it discovered that this was a task greater than it could perform unaided and alone. The infant railroad system grew rapidly to such gigantic size that to carry it taxed the financial strength of the government too severely, and very early in its railroad history Belgium was forced to intrust the construction of a portion of its railroads to private enterprise. In this way a mixed system of ownership has been developed in Belgium.

The government lines are managed by a bureau, over which a state officer presides, while the private lines are owned and managed by private companies, as our railroads are. In 1864, by consolidation of the lines, the proportion between these two systems stood as follows: In the whole country there were some twelve hundred and forty miles of railroad, four hundred and sixty miles of which were either absolutely owned or controlled by the government, while the seven hundred and eighty miles remaining were the property of private companies. Though thus the government had the control of only about one third of the railways, yet this was sufficient to enable it to practically control the whole system, and cause them all to be managed in the interest of the public, with

a unity of method, upon a fixed set of principles, and thus avoid the jarring of competition, with its constantly changing rates, and the antagonism which all unorganized competition of necessity produces.

The practical effect of this system was thus stated by the state officer of the bureau in control of the railways in his report for 1866: "The state railways thus find themselves placed in constant comparison with the railways worked by private companies, — on the one hand stimulating them to constant improvements, and on the other hand acting as a sort of check against any attempt to realize extravagant profits at the cost of the public."

Nor was this all; but the government, becoming aware of the importance which the railroad assumes in the development of a country's industry, since it has replaced all other methods of transportation, could afford to build a road, or an extension when needed, and not be forced to depend upon an immediate return, and thus, by putting the tariffs at reasonable rates, wait to be reimbursed until the industry of the section was established.

In 1856 an instance of the wise method which the Belgian government has pursued with its railway management was afforded. In this year it was found that the roads were losing money. Instead, however, of raising the rates in order to increase the receipts, the government lowered them considerably, trusting that the increased commercial activity which would be thus brought into being would bring about the desired end. So well did this policy succeed that, in 1861, a still further reduction was made in freights upon another class of goods, bringing about the next year an increase of seventy-two per cent. in the receipts.

The application of this action, which had been found to produce such advantageous effects, both upon the railways and upon the industrial activity of the country, is now the established rule for the management of the railways in Belgium, and in 1864 it was extended to all classes of freight, except small parcels, such as in this country are confided to the various expresses. From the report of the Minister of Public Works, for 1864, the following extract is conclusive as to the beneficial effects of this policy upon the industry of the country. The report says, "In eight years, between 1856 and 1864, the charges on goods have been lowered on an average by twenty-eight per cent. The public have sent 2,706,000 tons more goods, while they have actually saved more than $4,000,000 on the cost of carriage, and the public treasury has earned an increased net profit of $1,150,000."

Since the date of this report a still further reduction has been made in the tariff of freight charges, with the result of increasing the amount transported, in 1864, to 6,533,000 tons from 4,479,000 tons in 1863.

Encouraged by these results, in 1865 the government applied the same principle to the charges for passengers. A running scale of fares was introduced, diminishing in proportion to the distance travelled over twenty-two miles. Up to this distance the old rates, varying from 1.2 to 2.5 cents a mile, were retained, and above this distance they decreased rapidly, so that a ticket for a distance over one hundred and fifty-five miles was as low as a cent a mile for the first class, and seven mills a mile for the second class. The result of this was, that the travel for distances where the fare had not been reduced did not increase; for those where the reduction had been small the increase was small, while for those over forty-six miles, where the reduction was considerable, the travel nearly doubled.

The result, therefore, in Belgium of this system has been admirable. The railroads are managed in the interest of the collective public, instead of being privileged corporations, intent merely upon increasing their private gains. The roads owned by the state keep the privately owned roads in order, preventing them from taking advantage of their facilities for transportation to overtax the public, while the profit made by the state roads helps to pay the taxes of the people required for the support of the government. Besides this, there is harmony in the place of discord, unity instead of competition, and in the railroad business security takes the place of speculation, and confidence that of mistrust, while the entire influence of the railroads promotes the order, stability, and regularity which are so desirable in the operations of social and industrial life.

The Railroad System of England, and its Results.

In England the introduction of the railroad was left to the action of private enterprise, and it was confidently hoped that the best interests of the public, for the cheapness of transportation, would be best gained by opening the field, in the widest way, to the freest competition. Sir Robert Peel was in his prime then, and with a full conviction of the accurate working of the laws of supply and demand, believed that by their operation alone could the best results be obtained from the introduction of this new method of transportation.

He did not see, and there were but few at the time who did see, — the railroad was then too new for the data to have been gathered, from which alone a reliable opinion could be formed, — that the railroad is essentially and by its very nature a branch of the public interest, in which competition is impossible; and that the law of supply and demand cannot have the conditions of freedom which are absolutely necessary for its working. Every man who wants to use a railroad cannot build one for himself. A railroad is a public necessity; the very existence of many branches of industry are absolutely dependent upon it; and the stability and order, the security and regularity of commercial transactions, which are so dependent upon the ready circulation of the products of industry, could no more be intrusted to the selfish competition of private parties than the coining of money, the circulation of the measure of values, could be trusted to the same class of persons.

The result soon showed this to be the case. Railroads were projected, not because they were needed, or not for the purpose of developing the resources of certain sections of the country, but solely as a speculation upon the fears of competition of other lines already established. An era of speculation set in, and money was squandered with the profuseness of folly. Parliament began to legislate with an intelligence and an effect similar to that displayed by our own Congress during the gold speculations of the last war, when, by legislative enactment, it was attempted to regulate the price of gold. The rates to be charged for freight and passage were so involved in the complicated verbiage of innumerable acts of Parliament that it was about as impossible to arrive at a clear understanding of what it was necessary to charge, as it is to arrive at a clear comprehension of the provisions of our own tariff. There was competition among rival lines, until they combined together against the public; and this simple panacea for their own ills the managers soon showed a wonderful astuteness in discovering. The rudiments of the art of stock watering were invented. The virtue of fictitious dividends was made clearly apparent. The value of the stock of any railroad was a question to be decided, not by calculation of receipts and expenditures, but from the quotations of the stock board, where gambling, and not industry, is the recognized business of life.

With all this, to be sure, the roads were built and operated, and this benefit the public obtained; but there was no unity of pur-

pose, and no certainty of dependence to be put upon their action. The constant fluctuation in the tariff of their charges, according as competition or combination ruled the day, destroyed all possibility of precision, and forced all the industry which depended upon them for transportation to become more or less a gambling occupation. The reckless and loose manner in which things were done appeared recently in the discrepancy between the accounts of Sir Morton Peto and the London, Chatham, and Dover Railway. Sir Morton claimed that the railroad owed his house some six millions of pounds, while the railroad claimed that the house owed it some two millions of pounds. These amounts, taken from memory, may vary from the fact a million or two of pounds, but in such a case entire accuracy is of small value.

The result finally came. A commercial crisis, a railroad crash, and now there is no doubt that the entire railway system of England is bankrupt, while the necessity that Parliament should, as it has been suggested, take the management of all the railroads in England into its own hands, in order to save to the stockholders what fragments of their investments may remain, is steadily becoming more and more apparent. The injury and disaster which has been wrought in England among the honest and *bona fide* holders of the stock of the railroads, who had frequently invested their entire means in these companies, seduced into doing so by their confidence in the list of directors, is frightful to contemplate, and suggests how futile it is to trust to the integrity or capacity of an irresponsible body of directors, and how incompetent such a set of persons is to manage, with even ordinary financial intelligence, so important a branch of the public interests, upon which the well-being of society so greatly depends.

Legislation in such matters is as futile as to blow against the wind. Men are the result of their conditions; and what is wanted is some new method for the organization of the administration of such important public interests as the railway has become, upon entirely new principles, than simply those which have been found so utterly worthless to secure stability and security in the competitive organization of the railways in England.

The Railroad System in the United States.

In the United States, however, the railroad era has displayed a vigor of development as far surpassing that of any other country as the industrial activity of the people is pre-eminent among the

nations. The peculiarities of our social and political organization have also developed peculiarities and methods which are entirely our own. Here, as in England, individual enterprise and the virtues of competition were trusted as competent to introduce the railroad, and protect the public interest.

When the railroad was first introduced into the United States, there was not the knowledge or the experience in the world to thoroughly comprehend the nature of the influence it was destined to have, or to forecast its future. Politics had hardly yet become a science, while the method for the study of social questions had not yet been arrived at. Neither analysis, synthesis, or comparison, the only means by which any positive conceptions of social questions, or the requirements of social organization can be arrived at, could be applied to its consideration. The data for analysis had yet to be gathered by experience; synthesis, for the same reason, was powerless to act, while comparison was equally incompetent from the want of materials to compare. Had we been able to foresee that this new method of transportation was destined to replace substantially all others in use up to the time of its introduction, and that a new era of industrial and commercial activity would be founded upon it, more different from that it should replace than the social organization of a pastoral people differs from that of a savage tribe, who have not yet learned to domesticate any animals, or use their muscular strength for their own purposes, the importance of so organizing a control of it that it should be made the obedient agent of the public, instead of the tyrannical master, would have been clearly seen.

But so little were the politics of that time guided by a scientific method, and so entirely were its issues those of mere party, rarely, if ever, rising to the plane of universal principles, that, though the whole country was agitated upon the question of internal improvements, the railroad was allowed to enter in and usurp the place of the roads then engaging public attention, without its being suggested that it was a method of transportation much more worthy of the study of the people, since it was much more capable of subserving their needs.

This was the first mistake made with the railroad. The lines should have been built by the same system as that used with the ordinary roads and turnpikes. They should have been considered public property, and, as public improvements, have been built and operated in the public interest. But it is now too late to bewail

concerning what should have been, nor is it an American characteristic to thus waste the time. The chief point of interest is to obtain a clear idea of what is the present condition of affairs, and the best method for remedying the effects of our mistakes.

Combination vs. Competition.

Every one who is dependent upon a railroad, — and we are each of us in this condition, — either actually for our own travel, or proximately for the transportation of the industrial products which we consume, has an instance furnished him of how futile was the expectation that competition among the various railways would produce cheap fares. The physical condition of the United States prevented many attempts at competition. In a thickly settled country like Europe, divided into small states, and with important cities separated by short distances, there is room, perhaps, for competing lines; but even in the oldest settled portions of this country the important cities are widely distant, and therefore it requires so large an expenditure to connect them by a railroad that competing lines are almost impossible. On the other hand, also, at the time of the introduction of the railroad, the westward movement of emigration was gathering strength, and quickly recognized in the railroad its most powerful ally. Railroads in Europe are built to connect centres of population; but in the west the railroad itself builds the cities. Pushing boldly out into the wilderness, along its iron track villages, towns, and cities spring into existence, and are strung together into a consistent whole by its lines of rails, as beads are upon a silken thread.

Competition, in such circumstances, is impossible; and very soon after the commencement of the railroad era the process of combination began, and has finally produced the present era of consolidation. Elsewhere in this work we have already seen, with steam navigation, how prompt its introducers were to see the greater advantage to themselves of combination against the public, and thus to create monopolies in their own favor. The railroad was equally prompt in attempting the same thing, and from its more fortunate conditions has uniformly, so far, been successful. It is not too much to say, that in the railroad history of this country, the public has never, for a period of twelve consecutive months, been the gainer from railroad competition.

There have been quarrels and jealousies between rival boards of directors, as in the feudal times there was open warfare between

rival barons, who, from their strongholds, dominating the highways of that time, levied their tax upon the public traffic passing that way. But then, as now, these jealousies were personal, and were always promptly forgotten when the industrious public tried to take advantage of them for its own benefit; and the enemies combined in friendly leagues against their common victims, and sought to reimburse themselves for their losses by further exactions.

It is, and always has been, easier for the few than for the many to combine. They can the more readily see the common purpose which they have in view, and more promptly decide upon the best means at hand for attaining it. The feudal barons held their possession of the roads for traffic, and dominated the industry of their times chiefly by means of this. They had the single purpose of maintaining their possession of this means for gaining wealth. But it was a long and a slow process to combine the seemingly varied interests of the industry of that time. It required the culture of generations before the people became aware of their rights to freedom of circulation, and conscious of the best methods for obtaining them. With the increasing knowledge gained by experience, however, they came to question the claims of their hereditary rulers, and to find that the source of their power lay only in their own submission to their rule. The peasant, whose ancestors had paid without question for generations the taxes imposed by the lord for the right of transit over the road that their labor had constructed, came finally to question its necessity, and the overthrow of feudalism was at hand.

History repeats itself. With every generation a new position in the march of human progress towards the attainment of the best conditions for development of our faculties is reached, and with these new conditions, new social methods and new forces are introduced into social questions; yet human nature remains the same, and the principles underlying the phenomena of social progress are constant. It is only their application that varies from age to age, and the wisdom of a generation is shown in the wise application it makes of the lessons learned from the experience of the past, to the new combination of circumstances in which it finds itself placed.

As far as competition has existed, its effects have been far from desirable for industry. Stability and regularity are required for all industrial interests. The ability to forecast the future, and count with certainty upon the conditions, is absolutely necessary

in this modern era. The farmer who raises a crop becomes discouraged, if, when he is ready to send it to market, he finds the freights consume all his profits. In the year 1869, during the great railway contest between the New York Central and the Erie, freights between New York and Chicago fluctuated from five to thirty-seven dollars and sixty cents a ton, and between New York and St. Louis from seven to forty-six dollars a ton. While such a condition of things reduces all commerce between the chief centres of trade to mere gambling, with the demoralization which gambling necessarily produces, the country lying along the lines suffers even more severely than the centres. The following extract from a paper, entitled *Transportation as a Science,* read before the American Social Science Association in New York, in October, 1869, by Joseph D. Potts, the president of the Empire Transportation Company, shows conclusively the effects of railroad competition upon the local trade: —

"Usually competing lines, while they seek the same large centres of commerce, reach them through different districts. This confines their competition to the trade of such centres, while the traffic of the country peculiar to each line is not only uncompeted for, but subject to an extra and often oppressive tax, whereby to restore the revenue depletions each road suffers in its violent struggles with the others for jointly accessible business. The ability to unjustly burden uncompetitive or local trade, supplies transporters with strength to wage prolonged contests for other tonnage at less than cost of transport; and this wretched warfare, indirectly ruinous to the local business it overtaxes, is of little real benefit to the property battled, for as, sooner or later, truce is declared, and if the truce becomes a permanent peace, competition ceases; while, if but a temporary measure, it is presently broken, but only to be renewed; then renewed only to be broken; while the tax on trade fluctuates with the shattering or maintenance of covenants, until commerce is harassed, and dazed, and partially prostrated by its wild, illogical, and ruinous charges."

Consolidation and Monopoly.

To those who are interested in the democratic revolution of society, the history of railroad consolidation and monopoly is full of interest. The promptness with which this new agent of social activity has been seized by a certain class of men, and organized by them into a power more potent for their own domination than

royalty has ever been, except in a few cases, should well excite the fears of those who have no method to pursue in the study of the social destiny of mankind.

Here in the United States the political equality of our relations has offered, in the railroad, a field for the exercise of that kind of power which has a peculiar charm to men who have been bred in a commercial era and in a republican government. Great physical strength, personal daring, and the excitement of war were the objects desired and sought for by the rulers of feudal times. In an aristocratically constituted society, high social rank, with the social and political power it brings, are the objects men of this kind seek to gain. But in a democracy, and in a commercial age, the peculiar power which the control of capital gives, the influence which the management of a gigantic and well-organized industrial enterprise affords to its directors, form at once the incentives and the rewards for a life spent in labor and scheming. The excitements of the stock exchange, the contests of speculation, the victories of finance, the applause, the envy, and the deferential admiration of their fellows, are the ambitions which excite to action a class of men who, in other ages, in other social conditions, would have gone on a crusade to the Holy Land, would have risked their fortunes and their lives in a political intrigue, or have devoted all their energies to the organization of some vast scheme for the mental, spiritual, or political enthralment of their contemporaries.

The history of the railroad in the United States affords numerous instance of the truth of this. The railway monopoly of New Jersey has for years held the political and financial control of that state, and levied an onerous tax upon all travel between the east and south. There is no question that the monopoly of the Camden and Amboy Railroad has cost the state yearly more than the entire capital stock of that railroad in retarding its agricultural, industrial, and educational advance. As long ago as 1848 Mr. Henry C. Carey showed this most conclusively in a series of letters, in which, from careful statistical studies, he proved this fact. And yet, though this railroad paid for its monopoly only about one half of the taxation of the state, amounting, in 1870, to about three hundred thousand dollars, yet the inhabitants of the state have yearly submitted to this penny wise and pound foolish policy.

Nor is New Jersey alone in her railroad subjection. In Pennsylvania the combined monopolies of the mining and railroad interests not only control the legislative action of the state, but form

the chief influence which has so moulded the national administration as to lay a heavy duty upon every pound of iron and coal consumed in the country. It would be almost impossible to estimate the yearly cost to the people of the United States of the tax thus levied upon them for the benefit of these monopolies.

Maryland, Massachusetts, and various other states, east and west, find themselves to-day seemingly powerless in the grasp of railroad corporations their charters have called into being. With the growth of the principle of consolidation the evil is increasing, and the domination of the railroad is becoming national in its extent. Already the railway has stretched across the continent, and the directest path for the trade between the East and Europe lies through the United States. The history of the struggle between rival corporations to obtain the control of this trade would occupy us too long here, and is so recent that it needs be only mentioned.

Government Land Grants.

Though the railways in the United States theoretically depend upon private enterprise for their introduction, yet many of them have been aided with grants from the various states, either of money or credit. With the building of the Illinois Central, a commencement was made in the system of land grants, which has reached such gigantic proportions as to excite alarm.

In this way millions and millions of acres have passed under the control of the railroads, who thus are not only the holders of the means of communication, but of the land itself. The operation, as first presented by the railroad, had a certain air of being a legitimate business transaction. The land was wild, and the railroad proposed, by the building of its line, to bring it into the market for settlement, and therefore proposed that the government should give away a title to the alternate sections along the line on condition that the road should be built, and that the increased value of the remainder caused by the road would reimburse the government for that it gave away. In this view of the case such grants are in principle simply a commission paid an agent for making a sale.

That upon even this view of the case, the commission paid was too high, is shown from the enormous increase of the business, and the eagerness with which railroads are projected, chiefly for the purpose of thus getting possession of the land. During the congressional session of 1869 and 1870, schemes of projected railways

LAYING THE TRACK OF THE PACIFIC RAILROAD.

CROSSING THE PLAINS BEFORE THE PACIFIC RAILROAD WAS BUILT.

were presented to Congress, asking for appropriations of over two hundred millions of acres.

But to take a broader view of the subject. All history teaches that the possession of the land secures the control of the legislation, nor can the democratic character of our institutions make the United States an exception to this rule. The chief chance for the continuance of our republican government lies in the fact that ninety-nine hundredths of our population are landowners. The west has heretofore offered abundant opportunities for those who could not hope elsewhere to obtain possession of the land they lived on to gratify this desire ; so that there has been in this country no possibility of there being a body of landholders as a distinct class from the rest of the population, and who, thus easily united by their mutual interest, should control the legislation to suit their own purposes, regardless of the welfare of the community. When, therefore, the railroads of the west, in addition to controlling the means of transportation, come to own a sufficient proportion of the land itself to control the legislation, — and this is threatening as no very remote probability, — the danger of our republican institutions becomes immediate and serious. The despotism of feudalism depended for its support upon the sword ; but in the modern condition of society, legislation, financial methods, and the control of these are more efficient aids of despotism than the sword has ever been, since these influences are more subtle and more crushing than the sword.

Railroad Financiering.

With the vast expenditures of money required for the construction of the railroads, new financial methods became necessary, and in no department of industrial activity has greater ingenuity and fertility of invention been displayed than that developed by the railway financiers. The original subscriptions to the stock have only in rare instances been sufficient to construct the road, and the deficiency has been supplemented with bonds of every conceivable kind and description. In the press of the claims thus created, the original stockholders have generally found their investment a perpetual one, without interest ; but the roads have somehow been built, and this practical benefit secured to the public, even though it may have been at the cost of loss to individuals.

With the era of consolidation has arisen the practice of stock-watering. The mysteries of this system of financial engineering are almost too complicated and marvellous to be within the com-

prehension of any but those who are practically within the magic "ring" which performs its wonders. Many of the roads which have been thus consolidated have never paid any dividends, and in the ordinary judgment of industrial operations would be classed as commercial failures; but subjected to this process they have become instinct with financial life and activity, if we may judge from the wealth which the directors display.

The history of the various companies which have been consolidated into the Pittsburg, Fort Wayne, and Chicago Railroad, will give an idea of the methods pursued in stock-watering. The process of watering was early commenced by this road as a method of raising money at an enormous discount. The transaction was simply selling a certificate of a certain amount of stock for much less than it represented on its face, and has been thus described: "The stock subscriptions, which were paid in cash into the treasury of the company, were very small, amounting perhaps in all to less than three per cent. on the final cost of building and equipping the road. The stock subscriptions were paid for mostly in uncultivated lands, farms, town lots, and labor upon the road." "Of the eighteen million six hundred and sixty-three thousand eight hundred and seventy-six dollars, now representing the cost of the road and equipment, etc., the shareholders contributed in cash only about ten per cent., or less than two million dollars; and their contributions in cash, bonds, notes, lands, and personal property, labor, etc., amounted to something less than four million dollars, or rather more than twenty per cent. of the present cost of the work. The difference between this sum and the capital stock, as now shown by the books of the company, is made up of dividends which were *paid in stock*; interest on stock, *paid in stock*; premium on stock, allowed to stockholders at the time of consolidation, which was *paid in stock*; and a balance of stock still held by the trustees."

In 1866 the Fort Wayne Railroad commenced to pay dividends, and in 1870 the stock capital stood at eleven million five hundred thousand dollars, with a debt of thirteen million six hundred thousand dollars, being some one million one hundred and fifty thousand dollars more than the cost on the books. This year a lease of the entire property was made by the Pennsylvania Railroad Company, and the stockholders had their option between dividends of twelve per cent. on the stock then in existence, or seven per cent. on a proportionately increased amount. They chose the latter, and the

eleven million five hundred thousand dollars became nineteen million seven hundred and fourteen thousand dollars, and the road, which was claimed to have cost twenty-four million dollars, was represented by a capital of thirty-three million four hundred thousand dollars, bearing seven per cent interest.

This single transaction, among the innumerable ones which have taken place among the railroads which have passed through the process of consolidation, sufficiently represents the nature of stock-watering. When it is remembered that by similar transactions the fictitious capital in the country has been increased by hundreds of millions of dollars, and that the interest upon this is a direct charge upon the industry of the country, the subject is seen to be one of very serious interest, and one which must press in the immediate future for settlement.

The Future of the Railroad.

From what has been already said, it is evident that the proper organization of our railroad system is one of the most important subjects now pressing for solution. In the legislature of Massachusetts this subject has occupied attention during three or four sessions, and it has been proposed by the Board of Railroad Commissioners, in their report for 1871, that an attempt should be made by the state to introduce the Belgian system.

In Illinois, by the constitution of 1870, accepted by that state, provisions have been introduced forbidding the creation of any corporations by special laws; forbidding consolidations; providing that railways shall hereafter be considered "public highways, and shall be free to all persons for the transportation of their property thereon, under such regulations as may be prescribed by law. And the General Assembly shall, from time to time, pass laws establishing reasonable maximum rates of charges;" that all fictitious increase of the capital stock or indebtedness shall be void; and that extortion in the rates shall be prevented, if necessary, by forfeiture of the property and franchises of the roads guilty of it.

Whether legislation of this kind is competent to deal with the abuses of the railroad system remains yet to be seen. At least, however, it is a cheering sign that the public interest is becoming roused upon this subject.

Another plan proposed, by which the railroads shall be operated in the public interest, was offered to the Common Council of Boston, Mass., by the Hon. Josiah Quincy, and is well worth the at-

tention of the public. The possible cheapness of railroad transportation is a subject but very little understood by people generally. A similar remark might be made in regard to most articles of manufacture as well, especially when controlled by monopolists. Coöperation reduces cost wonderfully; and absolute monopoly is a pet of condensed "coöperation" in its results. They see in the railroad only a great industrial undertaking, requiring so large a capital for its construction and working expenses as to be beyond their individual resources. There are secrets in every business; and the railroad managers, understanding this fact, are very chary of giving such statements of their expenditures and receipts as shall be clearly and easily understood. With the advent of stock-watering the subject is still further complicated. In consequence, therefore, it is almost impossible, from the confused and garbled financial statements put forth by the various railroad corporations, to get a clear understanding of what is really the cost of the transportation of a ton of freight any certain distance.

Fortunately, though, we have this information prepared for us in a report of the Board of Trade, in London, England, for 1863. This report was made up from the returns handed in to the British Parliament from all the railroads in that kingdom, and can consequently be relied upon for its truthfulness and accuracy. From the remarks of Mr. Quincy, before the Common Council of Boston, we give the following extracts: —

"The following estimates of the English Board of Trade are made upon the principle that the ordinary current expenses of the establishment are paid, the railway kept in a state of efficient repair by the substitution of new rails and sleepers for old ones, and all other work of a similar kind which may be necessary, such as keeping the rolling stock, engines, wagons, carriages, and tracks in order, replacing them by new ones when necessary. All this outlay is comprised in working expenses. The average expenditure per train per mile, taking all the railways in the United Kingdom, has, according to the reports of the Board of Trade for the year 1863, been two shillings and seven pence (sixty-two cents) But it is necessary to note the different items which go to form the whole, and this we are able to do from the data furnished by the companies, and reproduced by the Board of Trade.

"It is to be observed that this average expenditure per train per mile includes goods, coal and other mineral trains, conveying two or three hundred tons each, as well as passengers.

"Average Cost of Conveying a Train a Mile.

	s.	d.	cents.
Maintenance of way and works	0	5½	11
Locomotive power	0	9	18
Repairs, and renewal of carriages and wagons	0	2¼	5
General traffic charges	0	9	18
Rates and taxes 1½*d.*, government duty 1*d.*	0	2½	5
Compensation for personal injury and loss of goods	0	0½	1
Legal and parliamentary expenses	0	0½	1
Miscellaneous working expenses not included in the above	0	2	4
	2	7 or	63

"The first three items, amounting to one shilling four and three fourths pence, or thirty-three cents, are direct. They are the actual expenses incurred in the conveyance of each train. The others, amounting to one shilling two and one fourth pence, or twenty-nine cents, embrace the general expenditure of the establishments, which must be paid whether the train runs or not.

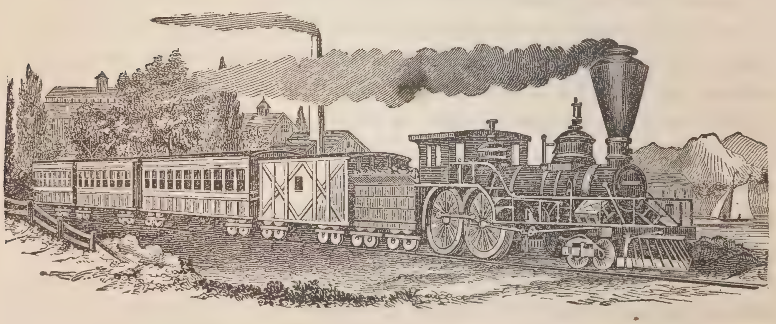
"Let us assume for a moment that the average prices per train in England are applicable to this country, — and it is for those opposed to the project to show how they differ, — and see what the result would be.

"So much for English experience. The presidents of railroads in America seem to find it as difficult as the managers in England to ascertain the expense per mile per ton. And, as we are informed by one of them, that they never divide expenses, except in their 'report to the legislature, which is made up arbitrarily the best way we can,' no satisfactory result can be obtained from them.

"I cannot conclude without a further quotation from Mr. Galt; he says, 'The policy hitherto acted upon by railway directors, and considering them as traders, — not an unfair one, — has been to keep the public in complete ignorance of the internal working of our railway system, so far as regards the extremely low rate at which passengers and goods can be conveyed on railways. When the public come to know that a passenger can be conveyed one hundred miles for twopence half penny, or five cents, for which he is charged eight shillings and fourpence, or two dollars, and that a ton of coal can be brought from the North of England for about a shilling (twenty-eight cents), the cost being there six or seven shillings, and the price in London four or five times that sum, it requires no prophet to foretell that the days of railway monopoly in private hands will, in this country (England), soon be numbered.'"

If these facts become generally known, there is no question that, in the United States, the people will soon arrange that the control of the railroads shall be taken from irresponsible parties, whose interests are adverse to the public, and so organized that the transportation shall be managed, in Mr. Quincy's words, "*by* the people, *for* the people." With the cheaper methods of construction necessary in building the narrow gauge railways, which are spoken of elsewhere in this volume, the expenses of railways would be even less than the figures given in the above estimate.

In the limits of an article like the present, it is manifestly impossible to enter fully into all the historic and industrial details of the railway; and the object with which this has been written was, therefore, to furnish suggestions of the tendency of the railroad system in the United States, and of the knowledge the world is gaining from its experience, by which this new agency, which threatens to rule the industry of the country, may be converted into its obedient servant. To bring about this most desirable consummation, it is only necessary that the people firmly resolve it, and wisely order it.



ROLLED SHEET BRASS.

THE CONSTITUENTS OF BRASS. — THE USE OF BRASS IN ANTIQUITY. — SCIENTIFIC METALLURGY. — THE ROLLING MILL. — THE CHIEF SEAT OF BRASS MAKING IN THE UNITED STATES. — THE SCOVILL MANUFACTURING COMPANY. — ITS HISTORY AND PRESENT POSITION. — THE PROCESS OF BRASS MANUFACTURE. — ROLLING. — ANNEALING. — STRIPPING. — THE SCOVILL MANUFACTURING COMPANY'S NEW PROCESSES OF GOLD AND SILVER PLATING. — OF THEIR FACTURES FROM BRASS.

Brass is an alloy of copper and zinc, in proportions commonly of about two of the former to one of the latter. It has been long known to the world and highly prized for its ductility, tenacity, beautiful color, and other desirable qualities. Among the ancients its market value was nearly equal to that of silver. The ancients supposed it to be not an alloy, but a pure metal. It first became known to them through the somewhat singular discovery of a mine containing both copper ore and that ore of zinc known as *lapis calaminaris,* or calamine stone. On fusing these ores the product was found to be, unlike other copper, of a yellow color, and they called it "yellow copper," a name still given to it by the French.

In the course of time it was found that the cause of the yellow hue was the calamine; and calamine, being found in other localities, was accordingly used to make brass, although the fact that calamine was itself metallic was unsuspected. It was thought to be simply a stone with a wonderful property of turning copper into a metal resembling gold, and the philosophers of that day, thinking that if they could only hit upon the right stone, they could turn copper into real gold, searched vainly during all their lives for the "philosopher's stone," which was to effect the wonderful transformation.

Pliny speaks of the use of brass soon after the foundation of Rome, and states that the workers in it were formed by Numa, the successor of Romulus, into a kind of guild, or community.

The early historians of Rome had not, however, any positive method in their historical studies, and depended so entirely upon mere tradition that their statements have no value for accuracy. Lucretius states that the use of brass was, however, before that of iron. The term he uses, which we translate brass, is *æs*, which is unquestionably translated more correctly brass, or some alloy of the metals, than copper. From the manner of making brass practised in antiquity, there is little doubt that the use of this alloy was quite common before the process was known of extracting any of the metals from their ores. In making brass the original discovery was for a long time repeated, the zinc ores were mixed with the copper found in a native state, and being heated together with charcoal, the zinc was absorbed by the copper without appearing at all in its pure condition.

We know that the Egyptians, as also the native Peruvians, made an alloy of copper and tin. Utensils of theirs have been found, which, upon analysis, proved this fact. The specimens of ancient European utensils, which are made of brass, or copper alloyed with zinc, are said to date first from about the commencement of the Christian era.

The method of making brass by fusing copper with calamine was practised throughout Europe until the close of the last century; but, as zinc ore of course varied in richness, and the science of analytical chemistry was undeveloped, it was impossible by this process to attain satisfactory results with anything like that certainty which the modern method of mixing definite proportions of metallic copper and metallic zinc permits. It was frequently necessary for them to re-melt their brass several times, adding calamine or copper as the case required, until finally they hit upon the right mixture. Modern science has changed all this. The brass caster of to-day mixes his alloys with scientific accuracy, and produces at will brass of every variety, suited to the manifold purposes to which it is applied.

One of the chief improvements made in the process of working metals in modern times is the introduction of the rolling and slitting mill, and the use of brass has been largely increased by the ability thus obtained of working it expeditiously and cheaply. The old process of working metals was almost entirely by hand; the metal was hammered out from the ingots into the forms required, or else cast when melted, and afterwards finished by hand. One of the first mentions of a rolling and slitting mill occurs in a work

written by John Houghton, F. R. S., published in 1697, and entitled *Husbandry and Trade Improved.* In this work the author describes some of the new processes introduced during his time in the working of iron, and mentions rolling and slitting mills as a new invention. At Middleboro', in Massachusetts, where iron works were established very early for the purpose of working the bog iron ore gathered in the sedimentary deposits of the numerous small ponds common in that vicinity, the first rolling and slitting mill in New England, and probably in the United States, was erected, though the precise date of its erection is not given.

In 1750 a report was presented to the British Parliament upon the condition of the iron trade, and the state of its manufacture in America. From this it appeared that at this date there were two rolling and slitting mills in operation in Middleboro', one in Hanover, and another in Milton, these three towns being in the colony of Massachusetts. These mills were chiefly used in rolling nail rods, from which spikes and nails were made by hand. This report was made the basis for an act of Parliament for encouraging the importation from America into England of pig and bar iron, and prohibiting the erection of any slitting or rolling mills, plating forges, or steel furnaces. This was one of the instances of the ignorant policy with which the "mother country" sought to repress the development of the colonies, and the accumulated force of which finally led to the rupture which secured the independence of this country. Like most unwise legislation of this kind, its effect was rather to stimulate than repress the introduction of such enterprises, and with the advent of the revolution, rolling and slitting mills became quite common throughout the colonies, and to-day the rolling mills of the United States will compare in efficiency with those of any other country.

The city of Waterbury, Conn., is the chief seat of the brass-making industry in the United States, where it now employs thousands of hands and millions of capital. The first brass rolling was begun about the year 1802, in Waterbury, by the firm of Abel Porter & Co., who were makers of gilt buttons, and rolled the brass for their own use. They had their ingots of brass partially rolled at an iron rolling-mill at Bradleyville, near Litchfield, and then finished the rolling themselves, on rolls measuring only two inches across the face, driven by horse power. In 1806 they sold out to Frederick Leavenworth, David Hayden, and J. M. L. Scovill, who, under the name of Leavenworth, Hayden & Scovill, continued the

business until the year 1827, when the first two partners sold their interest to William H. Scovill, and the name of the firm became J. M. L. & W. H. Scovill. Soon afterwards their factory was burned, but was soon rebuilt, and the business continued under that name until 1850, when the Messrs. Scovill, with other gentlemen, organized a joint-stock corporation under the name of the Scovill Manufacturing Company, with a capital of three hundred thousand dollars, which has since been largely increased.

Their business has continued to grow steadily ever since its beginning, and many new branches of manufacture have been added. Besides sheet brass, and German silver in all its varieties, they also make gilt and covered buttons, brass hinges, coal-oil burners and lamps, brass thimbles, and a variety of other small articles of brass. They also make sheet metal plated with gold, silver, or platinum, which is used extensively for the manufacture of coach lamps, carriage and harness trimmings, etc.

Their works at Waterbury are very large, the buildings extending in one line nearly a thousand feet, being for the most part three stories in height, and all built of brick. They have fine water power with a fall of thirty-six feet, operating one large overshot wheel and two turbines. In addition to these they have an engine of one hundred horse power.

Besides their works in Waterbury, they have a large factory in New Haven, where they make brass clocks and photograph cases and trimmings, and one in New York for photographic apparatus, such as cameras, etc. They have depots for sales in Federal Street, Boston, and in Beekman Street, New York, where they sell articles of their own manufacture, and also, at the latter place, deal in photographic materials, many of which they manufacture, although the metallic plates, once largely used, are now superseded by other substances. They are the largest dealers in the country in photographic materials.

In all their various departments, they have in their employ many men of life-long experience in the business, who entered their service as boys thirty or forty, and in some cases nearly fifty, years ago; and this, in so difficult a business as brass-making and brass-working, is a consideration of greatest importance.

The process of manufacture may be thus described: After weighing out the proportions of the metals, they are melted in crucibles, holding one hundred or more pounds, in the furnace. The fluid metal is then poured into cast-iron moulds, made of the finest qual-

WORKS OF THE SCOVILL MANUFACTURING COMPANY, WATERBURY, CONN.

ity of iron, and thus the brass ingots are formed. The moulds for some castings are covered with the best sperm oil. If properly managed, a crucible will last through thirty or forty meltings of brass; for German silver they will last for about twenty or thirty times casting. These crucibles are made of plumbago. The very best quality of Lehigh coal is used for melting brass, no other coal doing as well. The ingots are from six to fourteen inches wide, and from one to five feet long. They are usually one inch thick, and weigh about one pound to three cubic inches.

The casters of the Scovill Manufacturing Company have been in the business for periods varying from twenty-five to thirty years, and the skill required in this department insures a good caster a position for a lifetime. Skill, usefulness, and energy are absolute requisites to make a good caster. A certain heat, which is tested by the eye, but cannot be measured by the thermometer, indicates when the metal is ready to "turn off" for casting. The wages of a good caster range from one hundred to two hundred dollars a month.

These slabs, or ingots, as they are generally called, are then trimmed by cutting off with a huge pair of shears weighing several tons the *geats* (pronounced *gets*), or rough portions formed in casting by the mouth of the mould.

The bars are then passed to the rolls, which are of chilled iron, twenty inches in diameter and three feet long, and are reduced by degrees to the required thickness. All brass is rolled cold. It can only be reduced a little in thickness at one rolling. After passing through the rolls once it becomes hard and brittle, and before it can be reduced further must be annealed. The annealing is done in furnaces called muffles, which are shaped somewhat like ovens, 15×30 feet in width and length. Each time after annealing, the metal has to be cleared of the smoke and oxide consequent upon its exposure to the fire, and this is done by immersing it for a time in a bath of sulphuric acid.

At different stages in the rolling the surface of the metal is carefully scraped with steel scrapers, — or, as they are technically called, scratchers, — in order to remove all dirt, and disclose any flaws that may exist. If flaws are found too deep to be removed by the scratchers, the bar of metal is rejected and sent to the casters to be re-melted. The temper of brass depends mainly on the manner of rolling; the color, ductility, etc., upon the proportions of its ingredients. Lead, tin, and antimony are some-

times added in small quantities to produce brass of a quality suited to peculiar work. A machine operating a knife, or scratcher, by a cam motion, is used for the scraping. The plate, placed upon a movable bed, under the control of the workman, is passed under the knife. This is a new device in the operation of this part of the process.

The process of rolling affects the "temper" of the sheet up to the point where it begins to decompose the particles, or cause them to spread. The more the brass is rolled, the harder it becomes. The superintendent of the rolling process must know the composition of the material, and the temper which is required in order to perform the work as desired, and consequently needs great experience in order to be competent in his office. The "rollers" in this establishment are "life-long" fixtures in their positions, some of them having held them twenty-five years or more.

The cinders and waste of the fires are all put into a heavy crusher and reduced to a powder. The coarser particles of metal are then extracted by a sieve, by washing in troughs with a stream of running water. The finer ores are extracted by other processes. Thousands of dollars' worth of metal are thus saved annually, which was formerly thrown away. The scrapings of the ingots and the scraps of the sheets from which articles have been cut, are, before being re-melted, pressed together under an hydraulic press, which forces them into an almost solid lump, in order to prevent oxidation during the process of fusion. The greatest pains are taken in mixing, annealing, and rolling, in order to suit the requirements of the special purposes to which the brass is to be applied.

German silver, which is an alloy of copper, zinc, and nickel, is cast and rolled in the same manner as sheet brass, but is a more difficult metal to work, and requires greater care and skill. When the sheet of brass or German silver comes from the sulphuric acid bath, it is, of course, wet, and needs drying. Formerly this was done by hand; but now it is performed by forcing it through a bed of sawdust, under and over rollers which are covered with a soft cloth. By this process the sheet is made perfectly dry, while the machine does the work of some twenty men. When sheets of certain width are required, if the sheet is thick enough, it is sawed into proper sizes; or, if thin enough, it is "slitted." In the process of rolling, whale oil and lard are constantly used.

Besides the manufacture of brass, the Scovill Manufacturing

Company engage also in the production of sheet metal plated with silver, gold, and platinum. The processes are somewhat similar to those we have described in working brass. The ingots are rolled out under steel and cast-iron rollers, having first been plated. The silver is laid upon the copper, and pressed upon it cold. The process by which this plating is done is the invention of a Parisian, Mr. Eugene Martin, who has been with the Scovill Manufacturing Company for twelve years. This invention is the result of fifteen years' study and experiment upon his part. The copper plate is first made smooth and bright by scraping, and then the annealed plate of silver, very thin, is laid upon it, and made to cohere by a chemical process which is the secret of the inventor. The two plates are then drawn out under rollers to the required thinness. This process does not require the metal to be heated, and it is worked cold.

Mr. Martin has also a process for plating white metal used for screw heads and similar purposes, which will not tarnish. The metal in this process is also worked cold. By this process Mr. Martin is also enabled to plate sheets of metal two feet square, which by the ordinary methods of plating is impossible. Where silver, for example, is used for plating copper, it is impracticable to have the bar of copper at first over two and a quarter inches wide, on account of the difficulty of diffusing the solder over a wider surface, the danger being that, the solder not being evenly spread over the plate, the plate will blister under the rolling process. By Mr. Martin's process brass is plated, a result which can be reached by no other method, since the brass could not stand the heating and rolling operations, but would crack under them.

The stripping process, by which the gold and silver plating is removed from the scraps, which are to be used again, is done by a preparation of sulphuric acid. The scraps are laid into pots filled with acid, and are allowed to remain there from ten to fifteen or twenty minutes, according to the quality of the acid and the character of the metal. Gold and silver being thus equally treated, these metals precipitate themselves to the bottom of the pots. Mr. Martin has also made various important discoveries concerning stripping.

The cones and other parts for lamps are struck up in dies. Trunk checks, with the names of the various railroads, are cut here. Tubes for gas-burners are also made here. After one operation of stamping or drawing, articles made of brass, must be an-

nealed before undergoing a second one. Thimbles are drawn out by dies from flat pieces of metal, and undergo four "drops" before they are sufficiently drawn or shaped. In the manufacture of the brass portions of lamps, not less than six differently tempered kinds of brass must be used. The brass for the springs of the chimney must be of one kind, that of the ratchets to pull up the wick of another, and so on. The thimbles are burnished on spindles revolving fourteen thousand times a minute. The joints of brass hinges are turned by a patented machine of very ingenious construction. Brass buttons of all kinds, for naval, military, police, and other purposes, are made here. The chasing of gilt buttons was first done by the Scovill Manufacturing Company.

From the mention above of a few of the articles made by the Scovill Manufacturing Company an idea can be formed of the amount and complication of the business they do; but the organization of the various departments is such that they all proceed with regularity and order. A good evidence of the principles upon which the business is conducted, is given in the fact that the majority of those employed by the company have remained with them for periods ranging from twenty to thirty years.

The history of the brass business in Waterbury does as much credit to our Yankee force and enterprise as that of any manufacturing interest in America. Within the memory of living men the little village of Waterbury has been a by-word for its poverty. Now it is the fifth city in the state. The change is due to no natural advantages, but solely to the energy and enterprise of a few sturdy men, who, with scanty means, engaged in a business new to themselves and to this country, and by their own personal ingenuity and industry, aided by judicious protection, without which they could have accomplished nothing, made it successful. To those men Waterbury owes everything, and prominent among them were J. M. L. & W. H. Scovill, the founders of the Scovill Manufacturing Company.

HOISTING MACHINERY.

A TEST OF COMPARATIVE CIVILIZATION. — THE NEEDS OF MODERN COMMERCE FOR HOISTING MACHINES. — THE EARLIEST HOISTING MACHINES. — THE SKILL OF THE ANCIENTS IN CONSTRUCTING MACHINES. — THE ENGINEERS OF THE MIDDLE AGES. — THE PORTERS OF LONDON. — THE IMPROVEMENT IN HOISTING APPARATUS. — AN AXIOM IN MECHANICS. — THE PECULIAR CONDITIONS OF HOISTING MACHINERY. — THE HOISTING APPARATUS MADE BY OTIS BROTHERS AND CO. — THE METHOD OF ITS CONSTRUCTION. — ITS SAFETY APPLIANCES. — A DESCRIPTION OF THEM. — THEIR PASSENGER ELEVATORS. — WHERE SPECIMENS CAN BE SEEN.

In the modern world a test of the comparative civilization of various societies is best found in the appliances by which the necessity for expending muscular energy, in performing the work required, is dispensed with by the substitution of other methods for utilizing the forces of nature. With the increased activity of our modern commercial life, the handling necessary in the distribution of the products of industry has become a subject of paramount importance. A moment's consideration of the immense quantities of flour, corn, cotton, sugar, and various other articles which have every year to be stored in order to maintain a sufficient supply for consumption until the advent of the succeeding season matures a fresh supply, will make it apparent how dependent we are daily upon the safety and efficiency of the machinery devoted to this purpose. The increasing compactness of our cities has also introduced the necessity for higher buildings than were usual even fifty years ago, and with our hotels and large public buildings reaching up to five and six stories, an elevator which removes the task of climbing up long flights of stairs has become a necessity.

The earliest hoisting machinery used by men was, unquestionably, a simple pulley, a rope passed over a round pole, or some other equally primitive arrangement. The ancients, however, acquired considerable skill in constructing machinery for raising heavy

weights, such as the ponderous stones used in their architecture, and which they frequently raised to very considerable heights. In Europe, also, at the period of the revival of learning, great attention was given by the distinguished architects and engineers who flourished at that period to the construction of machines for handling great weights, and entire buildings were raised and moved by them. Da Vinci, Bramante, Michael Angelo, and other artists and architects, obtained not a small part of their reputation from their skill as practical engineers, and inventors of machines for performing such tasks.

But such works were not of the character of the hoisting machinery of to-day, nor were they devoted to the same purposes. The motive force applied to them was chiefly muscular energy, while they in no way contributed to lessen the task of handling the various burdens, the hoisting and transference of which become necessary in the daily business transactions of any city. In the application of machinery to dispense with muscular energy as far as possible in this department of commerce, the United States is preëminent. In the business streets of London, one of the tourist's sights is the porters who carry on their backs barrels of flour and other materials which are to be moved. Furnished with a kind of gigantic collar, the front of which rests against their foreheads, while the other end rests on their backs, forming, as they stoop forward, a sort of platform for the reception of a barrel of flour, long lines of them may be seen thus transferring cargoes to the upper floors of the huge storehouses. Such a sight is hardly to be seen in a city of the United States. Human beings are held at too high a rate to be made mere machines of, and the American quickly uses his brains in devising some mechanism which shall free him from the need of straining his back.

With the introduction of hoisting machinery, the same course of improvement has been gone through, which, in the consideration of various branches of industry treated of elsewhere in this work, we have found was necessary for the attainment of perfection. It was necessary that experiments should be made in order that sufficient data might be attained to arrive at a scientific conception of what was needed in a perfect hoisting machine, and thus to methodically design a machine which should fulfil the requirements.

The *first necessity* was evidently that the machinery should be SAFE. It is an axiom in practical mechanics that every working machine must wear out. The very laws by which its efficiency is

obtained require this. The ordinary processes by which power is communicated to and exerted by the machine render its continued existence and operation a course of gradual weakening. Though this is not immediately perceptible, yet from any logical consideration of the subject it will be manifest that it is so. With a hoisting apparatus worked by ropes, each time that it is used must, of course, diminish the strength of the ropes, and bring approximately nearer the time when the weakest spot, which measures the strength of the whole rope, and lurks hidden somewhere in its length, will yield, and bring disaster, and possibly death, to those using the machine.

Nor can this period, which must come, since it is as inevitable as fate, be more than deferred by increasing the size of the ropes, or by doubling their number. The fatal moment is thus merely put off to a later day. From the very conditions in which hoisting machinery is intended to work, this moment when the inevitable disintegration of the working parts brings about their rupture, is more to be feared than in almost any other mechanical combination. A machine which is applied to the performance of any certain work, breaks, and becomes incompetent to perform its task. The result in this case is only that the work remains unperformed. Such a contingency may be productive of very considerable annoyance, of loss of time and money, and, in some cases, by peculiar combinations of circumstances, it may result in an accident productive of damage and loss of life. But with hoisting machinery, the advent of the fatal moment when, while doing its work, the disintegration of its parts renders it incompetent to continue its operation, introduces a new combination of circumstances, by which disaster and probable destruction of life appear inevitable. The work of a hoisting machine is overcoming the power of gravity, and as soon as the machine becomes incompetent to this end, instantly gravity asserts itself, and the load descends with rapidly accelerated force to the earth again, bearing all obstructions before it, and frequently resulting in terrible disaster and loss of life.

In order, therefore, to construct a hoisting apparatus which should be safe, an entirely new method must be followed in which, to secure immunity from accidents, reliance was not placed upon any of the working parts of the machinery, but upon entirely independent appliances, brought into action upon the occurrence of an accident, in order to prevent any disastrous results arising from

it. By such a purely scientific conception and development of the required improvements in hoisting machinery, security in its use, and immunity from accidents arising from disintegration of the working parts, are made as nearly absolute as possible. This scientific conception has been developed, and forms the distinctive feature of the hoisting apparatus built by "Otis Brothers & Co."

In their elevators for factories, for use in hotels, or for other purposes, dependence for safety from accidents is not placed upon the working parts of the machinery, but upon special safety appliances, devoted only to this end, which, being brought into operation only when necessity occurs for their use, are exempt from the disintegration and weakening incident to the working parts of all machinery in constant use, and are consequently always ready to perform the part assigned them whenever occasion requires.

The machines now manufactured by Messrs. Otis Brothers & Co. have been perfected by a course of study and experiment devoted especially to the single object of the highest efficiency and the most perfect security in the design and construction of hoisting machinery. The fact that some two thousand of them are now in use, scattered all over the country, and that they have so proven themselves efficacious and safe, that the demand for them is constantly increasing, demonstrates that the manufacturers are right in claiming for them a superiority in their qualities which is not far from absolute perfection.

Their hoisting platforms and cars will not fall down should the rope break, nor back down rapidly should the working parts become injured by any accident, nor is their machinery liable to become deranged and inoperative when wanted. Their long experience as manufacturers has shown that, on the average, less than one machine in ten of their construction requires any repair before it has been in active operation five years; and, as a rule, they generally run ten years before it is necessary to stop and overhaul them. This admirable result is obtained by the extreme care exercised in their construction. All the material used is carefully selected from the best, nor is any poor workmanship permitted, so that the parts work together evenly, without any interference. This result is the better obtained by the organization of Messrs. Otis Brothers & Co.'s works, at which the machinery for every use of the hoisting elevators is built entire, and tested before it is considered complete; and thus careful supervision is exercised over the construction of every part, with the

further advantage that, when repairs are needed, the required part can be furnished without delay or trouble, and the machines guaranteed from all imperfections of material or workmanship.

In constructing these hoisting machines, the *chief* consideration kept in view has been *safety*; and this is more especially necessary in their application as passenger elevators for hotels, large manufactories, and public buildings of various kinds. The car, or platform, the lifting gear, and the engines which furnish the motive power, are all considered as component parts of the machine, and thus greater safety, facility, and economy in their manufacture and use have been obtained. The engines are provided with double cylinders, and are reversible. Both cylinders are connected with a single shaft, with cranks set at right angles, thus avoiding all chance of stopping upon dead centres. The steam passes from the cylinders by a single valve, which is so arranged as by a simple movement to reverse or check the current. The same movement which shuts off the steam closes the exhaust orifice, so that further motion of the engine is impossible, thus placing the car under absolute control, both in its upward and downward movements, so long as the gearings remain intact. By an arrangement of the reversing valve, its opening is graduated to suit the changed relation and action of the loading on the downward trip, and any excessive rapidity of motion is thus prevented.

The brakes are so arranged as to be brought into action and released with the starting and stopping of the engine, so that they do not act while the car is in motion, but hold it immovable when required. The engines give a motion to the car varying from fifty to two hundred feet a minute, the rate being always under the immediate control of the operator. The energy of the engine is communicated to the machinery by a belt, by which the noise and jar of rapidly-working gearing is avoided. The other gearings used are so accurately adjusted that the machinery works noiselessly and without any jarring. A "stop motion" is introduced into the mechanism of the engine, by which, after the winding drum has made the number of revolutions requisite for carrying the car to the extremity of its trip, the steam is shut off automatically, and it is impossible to start the engine again except in the opposite direction. This improvement is designed to prevent the crash, which may at any time occur, from the breaking of the hand rope, in hoisting machines unprovided with such an automatically working device.

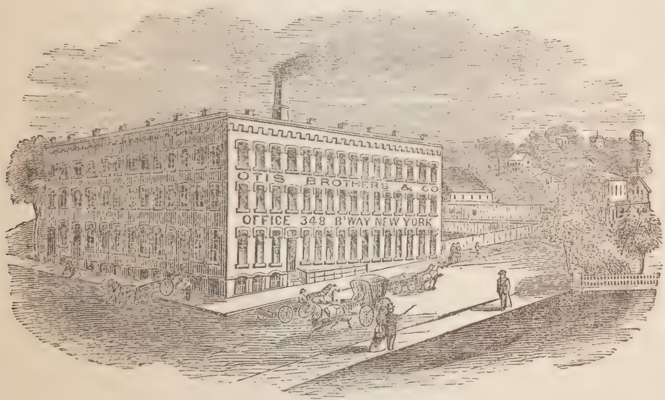
The running gear and guides by which the car is kept in place consist of rubber-faced wheels, acting upon planed iron guides, so that perfect freedom from rattling or jar is secured. The safety appliances by which the car is secured in the event of the rope breaking, from the inevitable disintegration to which it is subjected by use, are various, and are applied always in duplicate, each set being entirely independent of the other in every particular, and capable alone of sustaining the entire weight of the car, together with its load. The first of these safety appliances consists of heavy iron pawls, combined with powerful steel springs, and other suitable mechanism for forcing the pawls into contact with the safety ratchets, in case the lifting rope should break. The safety ratchets are of iron, very heavy, and having the strongest possible form. They rise from the ground, and extend to the highest point to which the car is to rise. Together with the pawls they have a peculiar conformation, which insures the perfect locking together of the two immediately following the slightest contact at the points, and renders their separation impossible, except by the lifting rope, when properly in order, and thus absolutely prevents the falling of the car, should the lifting rope break, a greater distance than that which separates the cogs of the ratchets, being three inches.

The safety drum is another safety device which guards against accidents arising from some derangement in the machinery, or some obstruction in the hatchway, whereby the ropes may be uncoiled from the main drum of the engine while the car remains temporarily lodged at a greater or less distance from the bottom. It is also a perfect safeguard against the too rapid descent of the car in case the belt, or any part of the gearing connected with the engine, should give way, or if run too fast by the carelessness of the operator. The safety drum takes the place of the ordinary sheave-wheels, and acts as the medium through which motion is communicated from the engine to the car. All ropes connecting from the engine to the car are arranged to act upon this drum, in such a manner that any derangement in their bearings, or change in their action, or increase of their motion beyond that prescribed as the regular working rate, will immediately bring into action two powerful brakes, and thus instantly stop the entire apparatus.

The special arrangement by which this effect is produced is such as could hardly be made plain enough here without a series of illustrations and an amount of description which our limited space

will not allow. In practice, it has, however, been proved that the immediate effect of the breaking of any one of the several ropes used in making the different connections of the apparatus, is to lock the car securely to the ratchets, by the instantaneous action of one or both of the safety fixtures, while, at the same time, one or both of the brakes are brought to bear upon the safety drum, and the car is thus doubly prevented from falling.

The ropes used in the construction of these hoisting apparatus are all made of the best steel, and each of them is capable of sustaining ten times the weight which can ever be brought to bear upon it. In the works of the Messrs. Otis Brothers & Co., not only is all the machinery of their apparatus made, but also the cars used in the elevators. In the construction of these the same consum-



MANUFACTORY OF HOISTING MACHINERY, YONKERS, N. Y.

mate care is taken, and strength, with a luxury of tasteful decoration, is a characteristic of their passenger elevators. An examination of this modern convenience in use at the St. Nicholas Hotel, at Lord & Taylor's, in New York; at Congress Hall, Saratoga; the Galt House, Louisville; the Maxwell House, Nashville; the St. Charles Hotel, New Orleans; and the Occidental Hotel, San Francisco, and as specimens, among the other numerous ones they have built, will show conclusively the merit of their work, and exhibit the reasons for the reputation they have gained.

The works of Messrs. Otis Brothers & Co., at Yonkers, N. Y., — a large and attractive brick building, — occupy the corner of Wells Avenue and Atherton Street, with a frontage of two hun-

dred feet on each. The first and second floors on Wells Avenue are devoted to machine and finishing shops, the third floor to storage of patterns, finished parts, etc., and a large water tank from which there are hose connections to the whole building. On Atherton Street are the cabinet and finishing shops, and painting, polishing, and varnishing rooms, etc. In the rear are the heating chambers for seasoning timber, the carpenter shop, and the lumber yard. Here, under ground, are water cisterns for ordinary use, and, in case of fire, kept constantly full. The basement story is occupied by the boiler and engine room, blacksmith shop, storeroom, and vaults containing hundreds of tons of forge and furnace coals. Throughout, order reigns supreme. The exquisite judgment and skill with which means are adapted to ends, may be illustrated by the manner in which power is distributed from the engine to the atmospheric hammer and bolt tools in the blacksmith shop, to the planers and saws in the carpenter shop, to the powerful lathes, planers, and bolt cutters in the machine shop, and the safety hoister. The gliding, horizontal motion of the engine, quiet as the action of a pair of human lungs in perfect repose, is communicated through perfectly-turned and adjusted shafting, by snugly-fitting belts and self-oiling pulleys, to the perfectly working machines, with such absolute certainty and ease that no power is lost. Everything denotes that here, at least, is one shop where there is a place for everything and everything in its place. Every man has his especial duty, and is doing it. The work goes on from Monday morning to Saturday night with two entire sets of hands, working day and night, yet there is no jar, no perceptible friction, no confusion, or disorder. No one need wonder that, from such a perfectly appointed shop, are turned out such perfectly appointed machines. Here is no mushroom growth; the business has developed by natural and perfectly healthy processes, from the small beginning under the elder Otis some twenty years ago, into an incorporated company with ample means. A visitor to these works sees no finished hoisters waiting customers; all are sold long before they are finished, and Messrs. Otis Brothers & Co. now find themselves confronted by the necessity of at least doubling their productive capacity. By careful, prudent management, and watchful supervision of all the details of their business, and manufacturing all parts of their hoisting machinery and cars in their own works, they aim to reduce the cost of production to the minimum, and being content with very moderate profits, are deter-

mined to merit a continuance of public favor and patronage. They are prepared to meet and provide for any demand for their incontestably safe and superior hoisting machinery.

The grand edifice of the New York Life Insurance Company, 348 Broadway (and in which is situated the chief office of Messrs. Otis Brothers & Co., while they have another office at the factory in Yonkers), is supplied with a beautiful model of their passenger elevator, kept in constant operation during business hours, and subject to the inspection of strangers to the city, as well as residents, at all times — a practical illustration of the perfection of Messrs. Otis Brothers & Co.'s work.

LEAD AND ZINC.

THE GREAT LEAD REGION IN THE UNITED STATES. — THE "GALENA," OR LEAD ORE. — "FLOAT MINERAL." — PIG LEAD. — PROCESS OF WORKING THE ORE. — PRODUCT OF THE DUBUQUE MINERAL REGION. — THE USES OF LEAD. — LEAD PIPE, AND ITS MANUFACTURE. — SHOT. — WHITE LEAD. — ZINC AS A PIGMENT. — ITS VARIOUS USES.

THE great lead mines of the United States are what are called the "Upper Mines," on each side of the Mississippi River, in North-western Illinois, South-western Wisconsin, and Iowa, and the "Lower Mines," found chiefly south of the Missouri River, in the State of Missouri. The Upper Mines were discovered by La Sueur, in 1700, and were worked from 1788 to 1809 by Julien Dubuque, a French miner, who owned the tract of land upon which the city in Iowa bearing his name now stands. When the United States acquired possession of this region, leases were authorized of the mineral lands, but none were issued till 1822, and very little mining done till 1826. In 1839 Dr. D. D. Owen was appointed by the government to make a geological survey of this whole district for the purpose of designating the mineral lands to be reserved from sale.

But the leasing system and the collection of rents were found to be attended with so many difficulties that, in 1844, the mineral lands were entered for sale. Dr. Owen reports the lead region as covering sixty-two townships in Wisconsin, ten in the north-west corner of Illinois, and eight in Iowa, extending, at the extreme limit, twelve miles west of the Mississippi. It is bounded by the Wisconsin River on the north, by the Apple River in Illinois on the south, and on the east by the eastern branch of the Pecatonika. The rock in which the lead veins occur is termed "galena limestone," and is a formation entirely western, not being recognized east of Wisconsin. Its position in the geological column is

between the Hudson River group and the Trenton limestone, with the upper layers of which the lower layers of galena limestone alternate.

The galena, or lead ore, is of a lustrous-black color, and breaks easily, with a cubical fracture. It is found in small quantities at the surface in the clay of the fields and forests, and is called by the miners "float mineral." These are indications of a crevice or wall of galena beneath. These walls are of various widths, often not more than a foot; but such narrow crevices are often parted from each other by only a narrow film of rock. The crevices of mineral often expand into pockets or chimneys, where the ore is in considerable masses and in great purity. In other diggings the lead is in flat deposits or sheets, so that a removal of the surface rock discloses an immense sheet or expanse of ore. One at Mills Lode was found twenty feet across, and from two to three feet thick, of solid galena. Over a million pounds were taken from it, leaving large masses still in sight.

Pig lead is obtained from galena, by roasting in a furnace not unlike a limekiln, using half a ton of charcoal to a ton of ore. The fire is lighted after the furnace is charged. In half an hour the mass becomes red hot, and the materials begin to flow. The working doors are then opened, and the charge pushed back and spread; quicklime is thrown over the surface, the effect of which is to dry up the slag and preserve the metal from oxidation. The fire is kept hot, with occasional alternations of cooling, for about four and a half hours, when the tap at the bottom of the furnace is opened, and the lead pours out with the slag. But the latter is pushed back, and the clear lead runs into the grooves carved for it in moist sand, and thus forms pigs or bars. In general five thousand pounds of galena yields three thousand of pig lead, much being left in the slag.

The quantities of lead melted in the Dubuque mineral region is large, but varies much according to the attractions of other fields of industry. In the year 1846 the quantity of American lead sold in St. Louis and New Orleans was about fifty-five million pounds. In 1858 the quantity was twenty-one million pounds, and the year previous only fourteen million. The war discouraged this industry, as also the more enticing mineral fields of the far west, which attracted, and still attract, the mining population. We import two or three times as much lead as we produce, the mines of England and of Spain furnishing us great quantities.

The chief use we make of lead is in the form of tubes, for water and other fluids. Some is rolled in sheets, for use on roofs in capping sharp corners, and much is melted and run into shot, or moulded into bullets. The amount of heat required to make lead a fluid is moderate, and the process of rolling lead into sheets is quite simple. The iron cylinders, through which a mass of lead not quite at a melting heat is made to pass, are geared and fitted with a screw, that permits their distance apart to be diminished as the lead becomes flatter from frequent pressure between them. In passing through from two to four hundred times, the length may be increased from six feet to four hundred. When the sheets become too long, they are cut, and the parts are rolled down to the required thinness.

Lead pipe is made in two ways. A short, thick cylinder is first cast of the exact bore required, and then drawn between suitable rolls, a long steel mandrel being kept in the portion passing through the rolls.

In the second method a hydrostatic press forces the melted lead through dies of the required size. The piston passes through a press under the floor, entering a strong, upright metallic cylinder. This is filled with lead, as required by a spout in the top, and the spout is then closely shut. Surrounding the cylinder is an annular receptacle for live coals, which keeps the lead within the cylinder at a melting heat. A steel die, of the required diameter for the outside of the pipe, is connected with the top of the cylinder, and through the centre of this die passes from the centre of the piston below the mandrel, which determines the size of the bore. As the piston is driven upward, the lead in the cylinder is forced into the annular space between the fixed collar or die and the mandrel, and emerging above, cools in form of a finished pipe, and is coiled on a drum suspended above the apparatus.

Shot is made of an alloy of lead with arsenic. Hard lead requires about ten parts or more in one thousand. Two or three tons of lead are melted in a pot, and this is surrounded with a circle of ashes or pulverized charcoal, into the middle of which the arsenic is introduced and stirred in. The pot is then covered and left several hours, when the arsenic is found combined with the lead. It is then tested, and when the proportions of arsenic and lead are found to be just right, the melted mass is run into bars, and taken to the top of the tower, where it is again melted and run through colanders. These are hollow, hemispherical iron disks,

or rectangular flat sheets, pierced with holes of uniform size. These holes vary from one thirtieth to one three hundred and sixtieth of an inch; but the shot is always of greater diameter than the holes through which it ran. A thin coating of the oxide of lead is kept over the colanders to hasten the cooling process. The shot fall through quite a height into a basin of cold water, from which they are taken, dried, and assorted. This is done by putting them in a revolving copper cylinder, slightly inclined and perforated. They are then placed in a revolving cylinder, partly filled with pulverized graphite, which polishes them to perfect smoothness. From this they are taken to the top of an inclined plane, and rolled down. Those which are truly spherical go to the bottom, while the imperfect ones roll off at the sides. Shot towers are of different heights, according to the size of shot required. The smaller shot can be made at the height of one hundred feet, but for the larger size one hundred and fifty feet are required. The highest shot tower in the world is at Villach, in Carinthia, and has an altitude of two hundred and forty-nine feet.

A process has recently been patented in the United States by which shot is made at a low elevation, by forcing a strong current of air upon it as it falls into the water.

Another important use to which lead is put is the preparation of oxide of lead, or white lead, as a pigment. In this branch of the lead industry this country takes a prominent and probably the leading position, as the practice of painting our dwelling-houses is more common than in any other country. The making of white lead is described in the chapter on Paints.

Zinc is a whitish metal, resembling lead and tin, harder than the former, and not so hard or so brilliant as the latter. When cold it is brittle, but heated beyond two hundred and twelve degrees it becomes ductile and malleable. The three chief uses of zinc are, first, rolled in sheets for roofing, lining tubs and tanks, and protecting wooden surfaces from the heat of stoves and furnaces; second, as a chemical solution in galvanizing iron; and third, converted by heat into a white, feathery powder, it is collected in flannel bags, compressed, and ground in linseed oil, making a brilliant white paint. Of zinc used in this country in a metallic form, the greater part is of foreign production.

The development of the zinc interest in this country is of recent origin, and, though inconsiderable in the production of sheet zinc and spelter, — the chief furnace yielding about three thousand tons

annually, — the amount of zinc-white, or flocculent oxide of zinc, ground in oil and sold as a pigment, is large, and increasing every year. The very best snow-white zinc, of which small quantities are used in the inside finish of the best buildings, is produced in France by the combustion of sheet zinc. The American zinc paints are made from the ore, and from certain of our ores pigments of great beauty and lustre are manufactured; but the impurities in some ores are such that the product is in no respect superior to common white lead.

When used in the manufacture of pigments, the zinc ore is ground fine, and mixed with half its bulk of fine anthracite. This mixture is thrown upon a burning mass of coal, and fanned by a blower sending a blast through the perforations of the grate of the furnace. As the products of combustion rise, a current of air is thrown into the chimney, and the zinc burns with a clear, blue flame, sending up the oxide in fine, white powder. This is carried up into a large cast-iron receiver, and thence driven forward, growing cooler and depositing the larger and darker particles, till the finest of it is gathered in rows of flannel bags. From these flannel bags the snowy powder is rattled down and removed at the bottom. It is then compressed, or wadded together, and taken to paint mills, where it is ground in linseed oil. As a paint, zinc is superior to lead in whiteness, and in the power of resisting discoloration from gases, and when properly condensed before grinding in oil, it may be made to have as much body or covering property, and is to be preferred to lead, as being less costly, and because it resists the darkening effects of illuminating gas.

From a mine in North Carolina, near Springfield, an ore is taken in which zinc, lead, and silver are blended in a remarkable way. When roasted, the Bartlett ore gives off a floss, or lustrous-white powder, of great fineness and brilliancy. Ground in oil, the Bartlett paint is produced, which keeps its body and lustre in any exposure, and bids fair to win its way to the first rank as a pigment. As yet the supply of ore has not been found sufficient; but other veins of this remarkable union of argentiferous galena with zinc occur in other parts of that state, and the quantity of this beautiful pigment ground each year constantly increases. The peculiar value of this ore has given an impetus to the development of the numerous mines of zinc known to exist in the southern spurs of the Appalachian range.

SMALL NAILS AND TACKS.

THE ANTIQUITY OF THE NAIL. — THE DERIVATION OF THE WORD. — THE USE OF THE NAIL IN ANTIQUITY. — A COMPARISON OF ANCIENT AND MODERN HOUSES. — THE NAIL AS A TEST OF CIVILIZATION. — VULCAN AND VENUS IN MODERN TIMES. — THE HAND MANUFACTURE OF NAILS. — THE FIRST ENGLISH MACHINE FOR THEIR PRODUCTION. — FISHER AMES ON THE HOME MANUFACTURE IN THE UNITED STATES. — ALEXANDER HAMILTON'S REPORT. — THE INDUSTRIAL POLICY OF ENGLAND TO THE COLONIES. — THE FIRST MACHINE-MADE NAILS AND TACKS. — OTHER INVENTIONS OF THE SAME KIND. — THE REPRESENTATIVE FIRM OF THE PRESENT DAY IN THIS INDUSTRY. — A DESCRIPTION OF THEIR WORKS. — THE MORAL EFFECT UPON INDUSTRY OF ITS SURROUNDINGS. — THE INCREASING CULTURE OF LABOR — THE FOUNDATION OF THIS ENTERPRISE. — ITS PRESENT MANAGEMENT.

The antiquity of the nail is proved as conclusively by the derivation of the word as if we had either the articles themselves, preserved from an antiquity dating far behind the settlement of Europe by the nations now found there, or a record of equal antiquity either in books or other competent monuments. The Anglo-Saxon *näjel,* the Old German *nagal,* the Danish *nagle,* and other European terms for the same instrument, in their evident phonetic relation to the Sanscrit word *nakha,* show that the nations of Europe brought with them the knowledge of the nail, as they brought the term for expressing it, from the distant home where they were in the early past united as one people.

As it is from the study of such simple words, descriptive of the daily wants of life, that modern philology has been enabled to reconstruct much of the past history of mankind upon this planet, so is it with the nail itself. Its abundance and its cheapness lie at the foundation of many of the arts and luxuries of modern civilization, and the student of social science may find the investigation of its history and use as valuable for a knowledge of the growth of progress, as the philologist has found in the study of the words

used to express it, suggestions for the history of races otherwise unknown.

While a pastoral people retain their custom of living in tents, made either from skins, or cloths, or branches, they must manifestly have but little need of nails for the construction of their houses ; and, at the same time, from the want of this simple appliance, must be dependent for their furniture upon such simple make-shifts as can be improvised without their use. Even the houses of the nations of antiquity, who had arrived at a position of great development in many of the arts, were singularly devoid of furniture, when contrasted with even the humblest cottage of the present day. One of the reasons why brick and stone were so frequently used in antiquity was the inability of the industry of that time to furnish the nails necessary for easy working in wood.

In Carthage, during its proudest days, the houses above the first story, were generally built of puddled clay. A modern balloon frame house, put together with studs only two by four inches, but so tied and strengthened by scientific methods of construction, that every nail holds to its utmost strength, so that the entire structure will blow over before blowing to pieces, is an evidence of greater constructive skill and experience than many an ancient ruin of stone, over which the sentimental tourist goes into raptures.

The distinction, however, between the houses of the ancients and those of the moderns, is more strikingly seen in the decorations of the interior, in the various appliances for ease, comfort, and simple decoration, which the abundance and cheapness of nails make possible now, but which all the wealth of imperial Rome, lavished upon the palace of the Cæsars, could not compass.

In modern times, also, the furniture of our houses has undergone a similar change in its character. The solid high-backed chairs of our ancestors, with the ponderous tables and high sideboards, are now replaced with lighter articles of more graceful forms, as the balloon frame has replaced the solid timber frames of our forefathers, in which so much wood was wasted, without the advantage of proportionally more strength. The nail has replaced the mortise and tenon, and economy of material, as well as economy of force, is the end we now seek to attain in our building, as in the business of life.

As a test of the comparative advance of different peoples in the race of civilization, with its consequent diffusion of comforts and

luxuries, their use of nails, and especially of small nails, might be used with advantage. In their house building, boat building, ship building; in their furniture, their upholstering, their decoration; in the countless utensils of domestic and agricultural industry, and in a thousand other specialties, the use of the nail is indispensable; and before industry could supply these, their existence was impossible.

In fact, had not mankind outgrown the tendency which has everywhere characterized the infancy of nations to personify their gods, and ascribe to divinities the beneficent establishment of their industries, as well as the advent of their misfortunes, Vulcan to-day would be more fitly represented as engaged in forging nails, than in manufacturing thunderbolts; while Venus herself would be much more attractively employed in persuading him to invent a tack or a brad, as a gift for some of her favorites upon the earth, than in getting him to make a suit of invulnerable armor, or a sword which should never become dull.

That the ancients, however, had no such legend to account for their possession of the nail, arose from the fact that the process of its manufacture was so simple that they could understand it. It was only the processes which they could not comprehend, on account of their complexity, which they felt obliged to account for upon some theory of divine assistance.

The suggestion of the nail was offered to mankind by Nature herself. The uncivilized man of early times, as the savage does to-day, found in the thorn an instrument better fitted for his use in attaching things together than anything he could make himself. With his increasing ability, however, to fashion to his own uses the natural materials he found about him, he would soon replace the thorn with pins of wood; and, as the use of iron is known to have been reached at a very early period,—so early, in fact, that all record of it is lost, nails must have been very soon made from this material, since its strength, its hardness, and its ductility make it peculiarly fitted for this purpose.

Among the nations of antiquity, and those of modern times, until quite recently, the manufacture of nails was entirely a hand process, each nail being hammered out upon an anvil.

In the modern history of the civilized world, England early assumed the lead in the manufactory of nails. Their consumption was great enough to make their production one of the chief industries of that country, as many as sixty thousand persons

having been estimated to be employed in this single branch of manufacture in and about the single city of Birmingham, which was the chief seat of this industry.

Though the process was almost entirely by hand until within this century, yet in 1618 a patent was granted in England, as appears from the records of the patent office, to Clement Dawberry, for "an engine worked by water, for cutting iron into small bars or rods, for making nails." Other machines were subsequently invented for drawing the iron rods, or forging them into the shapes in which they come into the hands of the nail-maker. At his hands the nail was fashioned with a hammer from the end of the nail rod, heated in the fire to redness, and then, being cut from the rod with a chisel, the head was formed with the hammer also, the nail being placed in the "bore," which was a piece of iron, with a steel knob at each end, perforated to the size of the shank of the nail, and countersunk to correspond with the head.

At about 1790 the first machine intended to do away with hand labor in the manufacture of nails was patented; it was, however, simply intended to use hammers, driven by water or some other power, for the purpose of working the nails in the same manner that they were worked by hand.

In 1790, however, a machine patented by Thomas Clifford was designed to introduce a new method. He used two iron rollers, faced with steel, into which were sunk impressions the shape of the nails to be made. One half of the form of the nail was in each roller, and these forms were arranged in lines running round the rollers, so that a bar of iron placed between the rollers was squeezed into a line of nails, the head of one being slightly connected with the end of another. The nails were afterwards separated with shears. He also proposed, by placing the lines of these forms close together, to convert, by the same process, a sheet of iron into nails.

It was also attempted about this time to make nails by casting them; but as they were found, by experiment, to be too brittle for any practical use, this method was abandoned. The nails made by all of these processes were still very dear, and in America, where wood, especially in the early times of the settlement of the country, was chiefly used as the material for house-building, the attention of inventive men was early directed to methods of cheapening their production.

The first nails made in the United States were manufactured by

the hand process in use in England. In the colonial times the manufacture was carried on as described by Fisher Ames, of Massachusetts, in a speech made before Congress in 1789, when it was proposed to put a duty of a cent a pound upon all imported spikes, nails, tacks, and brads, in order to foster this industry. During the debate Mr. Ames said, "This manufacture, with very little encouragement, has grown up remarkably. It has become common for the country people in Massachusetts to erect small forges in their chimney corners, and in winter and in evenings when little other work can be done, great quantities of nails are made, even by children. These people take the rod iron of the merchant and return him the nails; and, in consequence of this easy mode of barter, the manufacture is prodigiously great. These advantages are not exclusively in the hands of the people of Massachusetts. The business might be prosecuted in a similar manner in every state exerting equal industry."

In Alexander Hamilton's report, as Secretary of the Treasury, in 1791, in speaking of the consumption of iron, he says that the United States already supplied, in a great measure, their demand for spikes and nails, and were able to do so entirely. This increase of this branch of manufacture had been brought about despite the action of the English government; the policy of which, during the entire colonial period, had been calculated to make the colonies entirely dependent upon the mother country for all the manufactured articles they consumed. As an expression of what the English government desired, Lord North, during the discontent just prior to the revolution, declared that the colonies should not be allowed to make even a nail for their own use.

This short-sighted and selfish policy having led to the discontent which finally culminated in the struggle for independence, caused a spirit of resistance among the colonies, and led to the quite general formation of leagues, the members of which pledged themselves to use no imported articles, but to depend entirely upon those manufactured at home. The result of this condition of things was, of course, to increase the demand for home-made nails, among other things, and to stimulate the inventive genius of the country in the production of new methods for increasing and cheapening their manufacture.

About 1776, Jeremiah Wilkinson, of Cumberland, Rhode Island, who was engaged in manufacturing hand cards, used in preparing wool for spinning, found the price of the tacks used in their

manufacture so high, owing to the war of the revolution, which was then raging, and to the time and labor necessary to produce them by the hand process then in use, invented a way of making tacks by cutting them from a piece of sheet-iron with a pair of shears, and then heading them in a vice. This process he afterwards adapted to making cut nails, and he is, consequently, supposed to be the person who first produced nails in this way.

A machine for cutting and heading nails, invented about 1790 by Jacob Perkins, of Newburyport, who was one of the most active pioneers in the army of American inventors, was first used at Amesbury. It was patented January 16, 1795, and is said to have been able to turn out 10,000 nails a day.

Ezekiel Reed, of Bridgewater, invented, about 1786, a machine for cutting tacks and nails, which, being improved, was used at Abington, making in 1815 one hundred and fifty million tacks.

Jesse Reed, a son of the preceding, patented, in 1807, a machine for making and heading tacks at one operation, at the rate of sixty thousand a day.

In 1789 Samuel Briggs, of Philadelphia, memorialized the State Legislature and the General Congress on the subject of a machine for making nails, screws, and gimlets, and deposited with them, in a sealed box, a model of his nail machine, subject to their order. In August, 1797, he, with his son, received the first patent for a nail-making machine issued by the United States.

The second one was granted in February, 1794, to Thomas Perkins, of Philadelphia.

David Fulsom, also, in 1789, petitioned the legislature to protect his invention for cutting nails without drawing.

It is thus evident that about the same time inventions for manufacturing nails were made by various persons, in different parts of the country; and it is still a somewhat disputed point to whom the credit of absolute priority is due.

The business, however, having been thus established, in 1817 a patent was granted to Samuel Rogers and Thomas Blanchard, of Boston, Mass. This machine, known as the Blanchard machine, has, with Reed's, above mentioned, superseded all others. Important as has been its influence upon the large industry of nail-making, yet the patent was sold to a company for only five thousand dollars.

The representative firm, in the present day, of the manufacture of tacks and small nails is that of Messrs. A. Field & Sons, at

TACK MANUFACTORY OF A. FIELD & SONS, TAUNTON, MASS.

Taunton, Mass. In this manufactory over three hundred operatives are employed, and about two hundred and twenty-five machines of the Blanchard and Reed patterns, with an important improvement patented by Mr. William H. Field.

The buildings are over seven hundred feet long, and in their architectural finish, together with their inside decoration, and the order, neatness, and propriety of their arrangement, are at once models of industrial economy, and also a constant school for the culture of those who are engaged there.

In common with every other variety of organized life, men and women are the results of their surrounding conditions; and this truth, which is too often neglected in the arrangement and propriety of our industrial enterprises, is here fully exemplified. The moral influences of neatness, propriety, and order are seen at a glance in the character and deportment of the numerous women and children who are here usefully employed.

In the gradual advance of industry, from the *ergastula,* or slave pens of Rome, through the modified forms of villainage and serfdom in Europe, to that of citizenship in this country, with each step in the improvement of the condition of labor, the organization of society has been found to become more stable, and property to become more secure, in proportion as the material welfare of all classes has been increased.

The machinery used in Messrs. Fields' establishment is mostly manufactured by the company from their own patterns, and under their own inspection, so as to secure the best. The range of their manufacture includes about a thousand varieties of small nails and tacks, which are made of iron, zinc, copper, steel, and, in fact, from every variety of material used for this purpose. Over thirty-five millions of nails and tacks are made here daily, and, on an average, about two hundred boxes, or other packages, of nails and tacks, weighing, in the aggregate, between nine and ten tons, are daily sent out for distribution over the markets of the world.

Much credit in the organization of this vast industry is due to Mr. Elijah S. Caswell, for the mechanical skill which, during the thirty years he has been at the head of the cutting department, he has brought to bear in perfecting the machinery used. The visitor to this establishment will be, perhaps, most astonished at seeing in the cutting room the array of machines, which, for compactness, and the amount of work they perform, are probably excelled nowhere in the United States. Each machine cuts and

heads fifteen thousand nails or tacks an hour. Shoe nails are cut at the rate of fifteen hundred to three thousand a minute. Here are made, also, the famous chisel-pointed nails, used in boat building, and which are made by no other tack manufacturer. In the packing room is an admirably designed label diagram, showing at a glance in what drawer any desired one of the hundred and twenty varieties of labels used can be found.

The extent of the business is shown by the fact that these labels are provided by the two tons at a time. The leather-headed tacks, intended specially for use in putting down carpets, have also here a complete department for their manufactory. The scraps of leather from shoe manufactories are gathered here from far and near, and by machinery fashioned into the caps for tacks, which are at the same time driven through them. A girl operating one of these machines can leather 120,000 tacks in a day.

This establishment was founded by Albert Field, who died in 1869, at the age of 73. The success he met with is a proof of his business capacity and his talent for industrial organization; while the affectionate regard in which he was held by those whom he employed, and the confidence and respect he acquired in the community, are evidences of his high character. The business is now carried on as a chartered corporation retaining the old firm name, and under the direct management of Mr. George A. Field, president of the corporation, the oldest son of Mr. Albert Field, and who was practically engaged in the business with his father for nearly forty years, and of Mr. N. Bradford Dean, treasurer of the corporation, who has been for nearly twenty years connected with the house. Mr. Charles H. Field, also another son of Mr. Albert Field, is one of the board of directors of the corporation. Mr. Leander Soule, a practical tack-maker and able manager, is superintendent of the establishment. Mr. Otis Allen, who has had the direct charge of the packing and shipping department for over forty years, should not be forgotten in these notes, he having, by his peculiar talent in systematizing business, and by economical management, added largely to the effective force of the establishment. With a management like this, and ambitious to be excelled by none, it is not at all surprising that the tacks of A. Field & Sons are to be found in nearly every quarter of the globe.

BANKS AND BANKING.

THE MODERN ORIGIN OF BANKS. — MAN AN EXCHANGING ANIMAL. — BANKING IN ANTIQUITY. — THE NECESSITY FOR A POPULAR UNDERSTANDING OF FINANCIAL SUBJECTS. — THE MATERIAL QUESTIONS. — THE FIRST BANK ESTABLISHED. — THE CAUSES WHICH LED TO ITS FORMATION. — THE CAMERA DEGL' IMPRESTITI. — THE BANK OF GENEVA. — OTHER BANKS. — THE BANK OF ENGLAND. — THE ROYAL EXCHANGER. — MICHAEL GODFREY. — THE FIRST CHARTER OF THE BANK OF ENGLAND. — JOINT-STOCK BANKS. — SPECIE-PAYING BANKS. — BANKING IN THE UNITED STATES. — THE BANK OF NORTH AMERICA. — THE BANK OF THE UNITED STATES. — THE NEW YORK BANKING SYSTEM. — THE NATIONAL BANKS. — THEIR USEFULNESS. — THE PRESENT NECESSITY FOR A CHANGE.

The practice of banking and the establishment of banks belong entirely to the modern world. The nations of antiquity knew nothing about such practices. The passage in the parable of the slothful servant, "Thou oughtest to have put my money to the exchangers, and then at my coming I should have received mine own with usury," shows that the payment of interest was in use at that day, while Christ's attack upon the money changers in the Temple suggests how the business was then carried on. Of course, as man stands preëminently among the rest of the organic world as an exchanging animal, trade and barter were probably among the first methods introduced in pre-historic times as a means for gratifying the desires of the men of that period.

Among the Egyptians, from whom the Hebrews unquestionably derived many of their arts and customs, there must have existed an industrial society which had reached quite a degree of development. The government, like all governments in an early stage of the development of popular freedom, had organized an effective and oppressive system of taxation. For meeting the necessary expenses of building such enormous architectural monuments as still exist in Egypt, vast sums of money must have been collected and disbursed, even though the work was performed by slaves.

Anything, however, resembling our modern system of finance, was entirely unknown to them; or, rather, the simple germs from which, by the experience of successive generations, have been developed the financial and commercial methods now in use, were all that they possessed. Their money consisted entirely of coinage, and their only method of keeping it was by carefully guarding it in strongly built depositories.

It was the same with all the other nations of antiquity. In Rome, with all the luxury which the resources of the world poured into her lap, the convenience and cheapness of the modern commercial methods were entirely unknown. The money, for example, with which the Roman legions were paid, accompanied the army, and consisted of a store of gold and silver coins, which had to be carefully guarded, and was most difficult of transportation. Although within the present century the application of the new scientific method of study to the records of antiquity, has, in the hands of Niebuhr, Grote, and others of the same school, greatly increased our knowledge of the political significance of much of the history of those times, and has corrected a great deal that formerly passed as history, while the study of such subjects was pursued without method, and always in the interest of the rulers, still there is a great deal in the manners, customs, and methods of the daily life of the people which has not been as yet made clear to the comprehension of the modern world by careful coördination of the hints and suggestions which exist for such studies in the literature of the nations of that time.

Especially is this so with the financial customs of the ancients; how they gained, and kept, or used their money, and the effect which the want of our modern methods in these matters had upon the general intelligence and political independence of the people are still subjects of inquiry. It is difficult for us now to conceive the possibility of a large, cultivated, and industrial population existing without a bank, and much of the political subserviency of ancient times was caused by the very want of independence which such a state of things made necessary. The understanding and control of the medium of exchange are as important for the freedom of daily life as the comprehension and control of political subjects are to political independence, and, perhaps, even more so, since a financial despotism is more constant and subtle in its action than political tyranny, and enters more completely into all the daily relations of life. It is, therefore, but natural that, in the modern

world, and especially in this country, the course of social revolution has reached the stage in which the material questions have become the most important. By the possession of the right of suffrage the people have gained the right to take an interest in political matters, and control their organization in accordance with the best interests of their own morality and well-being. It is, therefore, strictly in the line of progress that the material questions should be subjected to the same process; and among them there is not one which is of more importance than that of banks and banking.

The first bank established in the modern civilized world was the bank at Venice, which was founded in 1157. According to some authorities it was founded in consequence of a loan which the state had felt the necessity of raising in order to carry on a war with the Greek empire in 1156–71. According to other accounts it was founded to meet the exigencies of the new condition of things caused by the crusades. The armies which swarmed from all parts of Europe to the East required some new commercial method for making use of the money they needed for their expenses. Whichever account is correct, there is no question but that, at first, it was simply a bank of deposit. Persons having money could place it in the hands of the bank and feel secure of its safety, while they were also able to have it transferred to the account of some one else upon the books of the bank, the money in such cases remaining in the possession of the bank. Slight as this convenience appears to us now, yet it was unquestionably a considerable advance upon those which were in use at the time of the bank's foundation. Subsequently this bank introduced the custom of transferring its deposits by drafts drawn by their owners.

The Bank of Venice was not, however, entirely a new creation (human institutions are never formed in that way), but was a modification of the conditions previously existing, to suit the new exigencies of the new conditions. It was a step in the direction of progress, a further differentiation in the growth of social organization. To meet the expenses of the state, contributions had been levied upon the most wealthy of its inhabitants, and a chamber of lenders (*Camera degl' imprestiti*) had been established for the purpose of managing the funds thus collected, and of paying the guaranteed interest of four per cent. to the lenders. From these creditors of the state was subsequently incorporated a company for the management of their mutual interests, and from this

the Bank of Venice was formed. This bank was consequently an incorporated body of creditors of the state, to whom the state gave certain privileges in compensation for withholding their money. The public debt was made transferable on the books of the bank in the same manner as is now done with those of many states, or with the stock of incorporated companies. One of its chief privileges consisted in the obligation placed by the state upon the merchants, to get their contracts, and draw their bills in bank money instead of in the current money of the city. The Bank of Venice was, therefore, essentially a bank of deposit, and not of issue, and this character it retained during the six centuries of its existence, until it was suppressed in 1797, when the armies of revolutionary France obtained possession of the city.

The slowness with which new methods of social organization were accepted and introduced in Europe during this period, owing to the moral stagnation of the times consequent upon the isolation and jealousy of the various communities, is shown by the fact that over two hundred years intervened from the establishment of the Bank of Venice to the next institution of a similar kind. The second bank in Europe was the Bank of Geneva, which was founded in 1345. The Bank of Geneva was projected in 1345, but did not go into practical operation until 1407. The Bank of Barcelona was established in 1401, and bills of exchange are said to have been first negotiated here. The Bank of Amsterdam was formed in 1609, as a bank of deposit and test for gold, the extensive commerce of that city at this time having made it commercially necessary to have some place in which the gold coinage of the various nations could be tested, and their value reduced to a common standard. In 1619 the Bank of Hamburg was founded for performing the same office for the silver coinage circulating in commerce. The profits of this bank were made by its charge of one half of one per cent. for testing the money deposited with it, and keeping it, subject to the owner's order.

The banking history of England is, however, of most importance here, as having had the most influence upon our own institutions of this kind. The practice of banking was unquestionably introduced into England by the Italian merchants, who were acquainted with the method of the art in use in Venice, and who settled in London in considerable numbers about the latter part of the twelfth century, and who, most probably, soon entered into relations with the Jews and the goldsmiths, who were at that time the chief

money-lenders in England, and even now have not entirely lost their traditional claim to this occupation.

Stow, in his *Survey of the Cities of London and Westminster,* published in 1598, says, "Then have ye Lombard Street, so called of the Longobards and other merchants; strangers of diverse nations assembling there twice every day. Of what original, or continuance, I have not read of record, more than that Eduard the Second, in the twelfth of his reign, confirmed a messuage, some time belonging to Robert Turke, abutting on Lombard Street toward the south, and toward Cornhill on the north, for the merchants of Florence, which proveth the street to have had the name of Lombard Street before the reign of Eduard the Second." This same locality has remained the financial centre of London until this day, and the proximity of the Bank of England, the Exchange, and the various offices of the other joint-stock banks and private bankers and brokers, which cluster here as thickly as bees in a swarm, make the value of the land dearer, it is estimated, than any other piece of the same size on the earth.

The early prejudice in England against the business of banking and dealing in money is shown in the following extract from Arnold's *Chronicle,* as occurring in the year 1278: "All the goldsmiths of London, with all those that kept the Change, and many other men of the city, were arrested and taken for buying of plates of silver, and for change of great money for small money, which were indicted by the wards of the city; and on Monday next after the Epiphany, the justices sitting at the Guildhall to make deliverance, that is to say, Sir Stephen of Pencestre, Sir John of Cobham, and other with that these last pleased to associate to them, and there were pre-judged, and drawn, and hanged three English Christian men, and two hundred fourscore and twelve English Jews."

The business of dealing in money was, in those "good old times," it is seen, not without other dangers than those which accompany it in these days; and it is singular to see the preposterous legislation by which, during the whole of the middle ages, it was supposed that this necessary business of society could be controlled or repressed. During this time the chief trade in money, which was all in coin, was in the hands of a number of persons called the royal exchangers. Severe laws were made against the exportation of English coin, and Erasmus gives an account of the annoyance he was put to on arriving penniless on the continent

from a trip to England, the custom-house officials at his departure from that country having robbed him, both actually and legally, of every penny in his possession. At the same time, also, exchanging the money of the realm for foreign coin, or for bullion, was held to be a special royal prerogative, worthy to be classed as a "flower of the crown;" and an important official, known as the king's exchanger, was alone entitled to exchange the coinage of the realm with merchant strangers for those of their respective countries, and to supply those leaving the country, whether strangers or natives, with such foreign money as they might desire to carry with them.

The house in which this business was carried on was called the Exchange, and from this our name for similar establishments is derived. This prerogative of the crown remained in force until the reign of Henry VII., when it fell into disuse, but was revived by Charles I., who, in 1627, issued a proclamation asserting that no person, of whatever quality, trade, or profession, had a right to meddle with the exchange of moneys without a special license from the crown. At the same time this king appointed the Earl of Holland to the sole office of "changer, exchanger, and outchanger." In answer to the dissatisfaction which this appointment caused, especially in the city of London, a pamphlet was published the next year by the king's authority, entitled *Cambrium Regius, or the Office of His Majesty's Exchange Royal.* In this it was stated that this office had been in existence without dispute from the reign of Henry I. until that of Henry VIII., when it ceased because the coinage of the realm had been so debased that it was not possible to exchange it.

The difficulty which mankind have created for themselves to retard their liberty of development in social evolution will be made even more apparent when it is remembered that this debasement of the coinage was also one of the acts of the royal prerogative, and was, perhaps, a worse infringement upon the rights of the subject than even the above-mentioned one. The era, however, was approaching when the principle of popular freedom asserted itself in the commonwealth, and Charles, by still further exercise of his prerogative, continued to gather the fuel for the conflagration which then burst out. Finding that it was the custom of the goldsmiths of London, who were then the chief money-changers of that metropolis, to deposit their money with the Master of the Mint in the Tower, Charles I. took advantage of this cir-

cumstance to seize, just before the meeting of the Long Parliament, about two hundred thousand pounds, calling it a loan. An act of the same kind was performed later by Charles II., by borrowing in the same manner one million three hundred and twenty-eight thousand five hundred and sixty-two pounds, which the holders had deposited in the exchequer for security.

These assertions of the royal prerogative tended to increase the business of private banking, which was carried on by the corporation of goldsmiths; and, as a contemporary pamphlet has it, "the goldsmiths began to receive the rents of gentlemen's estates remitted to town, and to allow them and others who put cash into their hands some interest for it." Money thus received was generally acknowledged by the goldsmiths in a receipt, which was transferable, and thus can be considered as the representatives for that time of the modern bank note.

In 1694 the Bank of England was established. The originator of the idea of this bank was William Paterson, a Scotchman, who seems to have been a man of a very comprehensive mind, and not to have been comprehended by his contemporaries. He was associated in the direction at the first, but soon left it. The subject of a bank had been before discussed in England, during the Commonwealth, and at the first council of trade which met at Mercer's Hall, after the restoration, a proposition was brought forward for "the establishment of banks and Lombards among us, as in Holland." When Paterson therefore proposed his plan, it was immediately accepted.

The bank was started with a capital of one million two hundred thousand pounds, which was to be lent to the government, which, in return, guaranteed an annual payment of one hundred thousand pounds, or eight per cent. on the investment, and four thousand pounds a year for the expenses of the management. The entire stock was subscribed in less than ten days.

The best evidence of the condition of the general intelligence concerning financial matters and methods in England at this time will be found in the following extracts from a pamphlet of the time, written in answer to some objections which had been brought against the bank and against its influence. This pamphlet was published about 1694, and was written by Michael Godfrey, the deputy governor of the bank. It has been reprinted in the Somers collection with the title *A Short Account of the Bank of England.* The author states that his object is to prove "that the

bank, notwithstanding all the cavils which the wit and malice of its opponents had raised, is one of the best establishments that ever was made for the good of the kingdom." As one of the peculiar advantages brought about by the bank, he notices "the ease and security of the great receipts and payments of money which are made by the bank, where people's cash is kept as it is at the goldsmith's," and he reminds his readers "how much money has been lost in England by the goldsmiths and scriveners breaking, which in about thirty years past cannot amount to so little as betwixt two and three millions, all which might have been prevented had a bank been sooner established. Beside providing this security," he continued, "the bank being thus useful to the publick, extends itself likewise to accommodate all private men's occasions, for they lend money on mortgages and real securities at five per cent. per annum, and their very publishing they would do it has given a check to the raising the interest on them from five to six per cent. per annum as was attempted ; and if the titles of land were made more secure money would be lent thereon at four per cent. per annum, and in time of peace at three per cent. per annum. Foreign bills of exchange are discounted at four and one half per cent. per annum, and inland bills and notes for debts at six per cent. per annum, and those who keep their cash in the bank have the one discounted at three per cent. per annum, for which most goldsmiths used to take nine or ten per cent. per annum. And money is lent on pawns of commodities which are not perishable at five per cent. per anuum, for which some, in their necessities, have paid more than double as much to the ruine of many great traders."

Another still greater benefit which the author predicts for the bank is, that "the bank, beside the raising one million two hundred thousand pounds towards the charge of the war, cheaper than it could otherwise have been done, and, like the other public funds, tying the people faster to the government, will infallibly lower the interest of money as well on publick as private securities. And the lowering of interest, besides the encouragement it will be to industry and improvements, will, by a natural consequence, raise the value of land."

The chief objections raised to the establishment of the Bank of England at this time were based upon political reasons, and were made by the conservative tory interest of the period. The bank was a whig measure, and was supported by the new administra-

tion, to which it brought most opportune and welcome financial aid. In the history of the progressive steps made by our own banking system towards a more democratic and universal character, we shall find the same political reasons lying at the basis of many of the obstacles put in the way of its success. It is rare that men have any method for testing their opinions upon such matters, or that they look to principles, instead of party interests, in judging of them. The history of the Bank of England is also of great value for reading the history of our own, since it shows that, while Mr. Godfrey was right in the advantages he claimed for the bank, yet the bank itself came to be the chief obstacle in the way of a further extension of the advantages of banks, demanded by the increased activity and knowledge of the people, and, as with our own banks, was blind enough to its own interest to suppose that they were best subserved by an obstinate adherence to measures the utility and value of which had long passed away, instead of advancing with the tide of public opinion towards the universal spread of financial freedom. So certainly and surely do all monopolies in the financial, as well as in the political and moral worlds, tend to injure their possessors by contracting their vision, and disenabling them to take a generous and large-hearted view of things outside of the petty circle of their own small interest, as well as wrong the public by depriving them of the use of their own powers, and compelling them to rely upon substitutes which, from the very nature of the case, must be inadequate to the desired end.

By its first and original charter the Bank of England was limited in its privileges; nor did its terms forbid the formation of any other banks, either of deposit or issue. Its success led to the inauguration of a series of schemes, one of which was a "Land Bank," intended to advance money upon landed estates. There was not, however, at the time a sufficient demand for its services to make it successful, and the bank failed after a short existence. Another scheme was the "Charitable Corporation Fund." It was started in 1705 with the object of encouraging commerce and industry, by taking money on deposit from the upper as well as the middle and lower classes of society — becoming, in fact, a sort of savings bank, and lending the funds it gathered to small traders and manufacturers, somewhat after the style common then and since in Scotland. It was at first so successful that its directors soon proposed to increase its capital, and subscriptions were flow-

ing in enthusiastically, when, all at once, it was discovered that the bank was insolvent. The directors had swindled the stockholders, falsified the accounts, and made away with nearly half a million of pounds. The governmental inquiry organized in response to the public discontent caused by this and similar proceedings, had for some time a great influence in destroying all confidence in the system of joint-stock banks.

In the year 1708 the Bank of England, which, though a private concern, had sufficient connection with the state to wear a character as a government institution, obtained, besides its other privileges, the passage of an act forbidding the formation of any other banks with more than six partners. In one of the clauses of this act it was provided that "during the continuance of the governor and company of the Bank of England, it shall not be lawful for any body, politic or corporate, united, or to be united, other than the governor and company of the Bank of England, or for other persons whatsoever, united or to be united, in covenants or partnerships, exceeding the number of six persons, in this part of Great Britain called England, to borrow, owe, or take up any sum or sums of money in their bills or notes payable on demand, or at any less time than six months from the borrowing thereof." This clause put a stop to the further introduction of the joint-stock system of banks in England for one hundred and twenty-five years, and against its repeal the influence of the Bank of England was strenuously and constantly thrown with success. It will appear, perhaps, singular to those whose studies of such matters have not destroyed all the novelty of any new instance showing how prone men are to accept statements upon trust, and how rare is the mental habit which demands and seeks proof before accepting an opinion, — it will appear singular that, though the entire mercantile interests of Great Britain felt the necessity for a more general diffusion of banking facilities, and the folly of intrusting so vast and complicated interests to the control of a single irresponsible institution, yet no one during all this time found out that the terms of the act under which the bank claimed and upheld its monopoly, were as incompetent for this end as most of the legal verbiage of legislative enactments is for the purposes they are intended to perform.

The tendency of monopolies, also, to blind their possessors to their own best interests, is shown in the course constantly pursued by the bank itself. No measure has been productive of more le-

gitimate advantage to it in its own peculiar sphere of interests than the establishment of other joint-stock banks, since by their means the financial, the commercial, and the industrial activities of England have been greatly stimulated, and it is to the healthy condition of these activities that all legitimate banking institutions owe their own financial activity, since a bank is not an institution with interests apart from the general well-being of society, but is one of the complex series of organizations in which the morality, the knowledge, and the activity of the times are expressed.

As we have seen, the first banks established were really specie-paying banks. They were dealers in money when the only money in circulation was metallic, and were consequently specie-paying banks from the necessities of the situation. A people, however, who depend only on a metallic currency for the transaction of their commercial affairs, cannot have arrived at any advanced stage of commercial or industrial development. The world might as soon attempt to confine itself to the old roads, the foot messengers, and the other appliances formerly in use to supply the needs for the circulation of its industrial products and its intelligence, as to confine its monetary circulation to that of gold and silver. Yet the Bank of England still keeps up the tradition that it is a specie-paying bank, and Sir Robert Peel's famous bank restriction act of 1844, by which the circulation of the bank's notes was limited to a certain accordance with the reserve of coin kept in its vaults, is still unrepealed. And this, too, notwithstanding that the best political thinkers of England have, time and time again, shown the folly of this measure, and though the bank itself has on several occasions been forced to suspend specie payments, and apply to Parliament for permission to take this course, and though at no time in its history has it ever had the gold which would have been necessary to pay the possible demands upon it. In 1857, one of the occasions when the bank suspended, the gold and silver coin in its vaults amounted to £504,443, its reserve of notes to £957,450, while its liabilities reached the sum of £19,103,078.

Various attempts to remove the monopoly of the Bank of England were made during its continuance, and the dissensions concerning it served to increase the knowledge of the public concerning the mysteries of finance. In 1797, during the continuance of one of the periods while the bank had suspended specie payments, Sir William Pulteney introduced a bill into the House of Commons providing for the erection of a new bank in case "the Bank of

England did not pay in specie on or before the 24th of June, 1797." In urging his bill he gave a detailed history of the bank, pointing out the mischief produced by monopoly, and urging that it was nothing but a premium for indolence and neglect, and productive of endless mischief to the trade and commerce of the country. By the force of his reputation, however, Mr. Pitt, having spoken very strongly in favor of the bank monopoly, retained it.

Three years afterwards the subject was brought up again in the House of Commons, but was again lost, the bank having bribed the support of the government by an offer to lend, without interest, three millions of pounds to the government on the security of exchequer bills. This course was again successful, and Parliament renewed the bank's monopoly from 1813, when it would have expired by its own limitation, to 1833.

In 1826 a bill was brought before the House of Lords, which had been passed by the Commons, permitting joint-stock banks in England, "except in London, and within a distance of sixty-five miles thereof." The prime minister, the Earl of Liverpool, on this occasion spoke as follows: "The present system of law as to banks must now be altered, in one way or another. It is the most absurd, the most inefficient legislation; it has not one recommendation to stand upon. The present system is one of the fullest liberty as to what is rotten and bad, but of the most complete restriction as to all that is good. By it a cobbler or a cheesemonger may issue his notes without any proof of his ability to meet them, and unrestricted by any check whatever, while, on the other hand, more than six persons, however respectable, are not permitted to become partners in a bank with whose notes the whole business of the country might be transacted. Altogether, the whole system is so absurd, both in theory and practice, that it would not appear to deserve the slightest support if it was attentively considered even for a single moment."

The only result, however, of this consideration of the subject by the collective wisdom of the hereditary legislators of the country, was granting the privilege of forming joint-stock banks to the country, but limiting London and a circle of sixty-five miles around it as a preserve for the Bank of England to hunt its financial game. In 1830 another strong effort was made to remove this sixty-five miles clause, when it was discovered by Mr. James William Gilbert, the subsequent founder of the London and Westminster Bank, that the act did not provide against the establishment of banks of

deposit; and the correctness of his opinion being substantiated by the opinions of the law officers of the crown, the London and Westminster Bank went into operation in 1834, despite the frantic efforts of the Bank of England to preserve its monopoly.

From that time to this the tendency of the English banking system has been towards freeing banking from the absurd restrictions which were placed upon it before the advent of the causes which have so increased the activity of our modern social and industrial life. Many of these measures, though as necessary at the times they were passed as swaddling clothes are to an infant in the arms, are now become as unsuitable for the wants of the modern world as this childish fashion of clothing would be for a grown and active man. The traditional confidence in the stability of a metallic currency, despite the experience of the world to the contrary, is as firmly displayed in the banking and financial policy of the English bankers as the traditional reverence for the divine rights of royal legitimacy is still the characteristic of the political faith of the average monarchist.

At the settlement of this country the colonists brought over with them the financial theories and practices which prevailed at the time in the mother country. One of the chief difficulties they met with in organizing and increasing their industry was the want of money. As has been seen elsewhere in this work, very soon after the settlement of Massachusetts various substitutes for a metallic currency were used, while in Virginia the circulating medium was tobacco. The history of the progress of the financial methods used up to the revolution, and during that contest, is most suggestive for the right comprehension of our national development, but there is not the space to pursue it here. At the end of the revolution the country had, by the continuous strain upon its resources of an eight years' war, been almost entirely drained of its wealth. To carry on the contest, the issues of continental currency had reached the enormous sum, for those times, of three hundred millions of dollars, and this, by its continued depreciation, was practically worthless as a circulating medium.

In 1781 Robert Morris, who had done such substantial service in the financial administration during the revolution, proposed a plan for a national bank, which was incorporated under the title of the Bank of North America, and went into operation in 1782, with a capital of four hundred thousand dollars. In 1790 Alexander Hamilton proposed a plan for the Bank of the United

States, and in 1791, the act of incorporation being passed by Congress, the bank accepted the charter granted, and went into operation with a capital of ten million dollars, and continued in active existence until 1811, when, by the limitations of its charter, the time for its existence having ceased, it wound up its affairs, and ended its corporate life.

In 1814 another national bank was proposed, but the next year, the bill for its incorporation having passed Congress, was vetoed by President Madison. In 1816, the measure having again passed, the Bank of the United States, with a capital of thirty-five million dollars, went into operation in 1817. The management of this institution, copied too much from that of the Bank of England, having created great discontent by the aid it afforded to speculation, and to certain classes, instead of to the general industry of the country, President Jackson, in 1832, refused to sign the bill granting its continuance, and in 1836 it ceased to exist as a government institution by the limitations of its charter. The State of Pennsylvania having, however, granted it a charter, the bank continued, under a different character, but with the same name, until 1839, when it suspended, having exhausted, by the injudicious management of its directors, the whole of the stockholders' subscriptions. This was the second and last suspension of the bank, it having incurred this misfortune once before, in 1837, when, from one of the commercial crises to which the country has seemed to be periodically subject heretofore, it, in common with all the other banks then existing in the country, had suspended payment.

The first bank established in Boston was instituted in 1784, and in 1799 the first bank was opened in New York. In 1829 the safety fund system was inaugurated in New York State, as a protection for the safety of the holders of the bank notes issued by the banks of that state, but was abandoned after a while, on account of its having been found insufficient in a crisis during which ten banks failed. The necessity, however, for an improved organization of the banking system, by which the interests of the public should be guaranteed from the swindling schemes of the various banks which might be under the control of unscrupulous men, and to change the character of them all from being irresponsible to the public, and introduce security into the business, became yearly more and more apparent, as the increased industrial activity of the country demanded greater banking facilities. The result of the knowledge gained by experience, and by the general discussion of the whole

matter, led finally, in New York, to the passage, in 1839, of free banking laws, in which any persons desirous of so doing could engage in the business of banking, but were required to guarantee the safety of the bank notes they issued, by the deposit with the comptroller of the state of a sufficient amount of securities to meet all their bills, should they fail, from injudicious speculation, or from any other cause.

In 1840 the law was revised, giving the banks the right to deposit with the comptroller, as security for the redemption of their bills, either United States bonds or those of the State of New York, or bonds and mortgages upon real estate in New York State. By this simple arrangement perfect security was given the holders of the notes issued by banks in New York State, and they circulated at par all over the state, and elsewhere in the country where the system was understood. No New York State bank had the right to issue bills unless they were countersigned and stamped by the comptroller, who would thus give currency to no more bills than were made safe by the deposit in his hands of securities to the amount so issued. The saving to the public was, of course, great, not only in the surety thus given that no bills were issued which were not guaranteed for payment, and also by the fact that such bills circulated without discount.

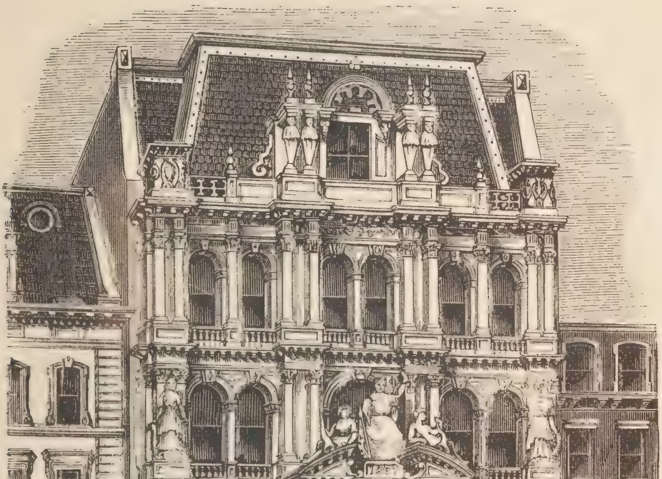
The banking system of the rest of the country was at this time in a sad state of confusion. Banks were everywhere established upon insufficient capital, frequently for no other purpose than to issue as many notes as possible and then fail. The discount which prevailed on bank notes at times, even in the towns in the vicinity of the bank, and in all cases in different states, was a most serious charge upon the industry of the country. Not unfrequently this discount amounted to as much as ten per cent., and enterprises, such as newspapers, which received remittances of money from various parts of the country, were obliged to consider this amount as the average of their loss from remittances on account of the discount for converting bills thus received into bankable money, and from the bills they received which became worthless on their hands from the failure of the banks before they were redeemed. So thoroughly disorganized was the banking system of the states, that issuing lists of the worthless bills became a regular and important business.

In Massachusetts, a system intended to afford security to the holders of the bills issued by the banks of that state, had been put

in operation. The bills of the country banks were redeemed in Boston by the Suffolk Bank, thus acting as the agent of those country banks which kept deposited in its hands the securities required for the redemption of their issues. This system was a good one, but for efficacy was not equal to that adopted by New York State.

Another improvement in the banking system, though intended chiefly to facilitate the business of the banks themselves, was the clearing-house, which was established in New York city in 1853. Previously to this each bank kept a messenger, whose daily task was collecting from the various other banks of the city the checks against them which came into its possession by the transactions of business. The clearing-house is a place of meeting where these messengers attend every morning, and the balances only of accounts between the banks are settled. It frequently happens that accounts amounting to many millions of dollars are thus settled in an hour with the actual transfer of a few hundreds of dollars. The economy of time, and the greater simplicity and regularity which the introduction of this system has introduced, make it one of the most noticeable reforms in the banking system which has been recently brought about, and it is singular that a similar system of organization has not been introduced into many other branches of our industrial activity where it is equally needed, and where it would be equally competent to simplify the present complexity of details, and introduce a great economy in the present wasteful expenditure of time and energy necessary for the transaction of the needed exchanges.

With the advent of the late civil war the expenditures of the government necessarily assumed a magnitude which so disorganized the working of our finances that some decided change became necessary. Fortunately the idea of forming, not a single gigantic national bank, but a series of national banks, which should introduce a uniformity of system into our banking operations, and combine the energies of the people in support of the government, was entertained by the heads of the administration, and to Salmon P. Chase, who then held the position of secretary of the treasury, the country is indebted for the introduction of our present banking system. This innovation was simply the extension, all over the country, of the system which had for years prevailed in New York State. The national banks invested their capitals in the bonds of the government, and by the deposit of these in the hands of the



PARK BANK, NEW YORK CITY.

treasury, received a proportionate amount of their value in notes, countersigned and issued by the department, and thus provided for the public circulation an issue which was guaranteed by the credit of the national government, in the support of which the collective wealth of the nation was engaged.

The unity and uniformity of the currency, together with its stability which have thus been secured, make this banking reform of perhaps equal value with the abolition of slavery, produced also by the war. A national bank bill now circulates, without question, and at par, from Maine to Oregon, and the industry of the country is no longer subject to the annoyance and loss which were formerly the inevitable accompaniments of the insecure, unstable, and irresponsible currency furnished by the banks of ten years ago. Such a reform as this is one of the most influential in producing the unity of our national life, and a coherence of organization in the formerly divided and isolated portions of the country, and is thus entirely in accordance with the new era of the world, which tends towards introducing union and the mutual sympathy of a common destiny among mankind in the place of the jealousies and isolations which have hitherto marked the progress of humanity upon this planet.

But while we thus recognize the benefits of the national bank system, and fully accord to it all the merits it deserves, we must not lose sight of the fact that, like all other reforms in social and industrial organization, it but prepared the way for another step. At the date of their formation the national banks were an important improvement in our financial system, but the necessity for them has passed. They have fulfilled their function, and are now an obstacle instead of an aid to our further national progress in financial organization, and must, in turn, give place before the increasing knowledge of the people to a better, because more simple and economical, method for providing the circulation needed for the activity of our industrial life.

Elsewhere in this volume, in the article upon the TREASURY, will be found an account of the methods proposed for providing a currency which shall not cost the public, as that now furnished by the national banks, the thirty millions of dollars a year interest upon the bonds by which it is secured. Furnishing a currency is the natural function of a government, and delegating this function to the national banks is a mistake in the organization of a financial system akin to the want of simplicity in a machine. The condi-

tion of things at the time of the war rendered it necessary, but the necessity has now passed.

Against this proposed change the national banks of course protest. To do this is but natural, and in so doing they do not vary from the course pursued by all monopolies, to whom the proposal for their removal by the substitution of a greater simplicity of organization seems always to be an error. But against the wish of the people, when, with a better comprehension of their needs, and a wiser understanding of the proper means to take for attaining the organization that shall best satisfy them, they determine upon the change, all monopolies are helpless to resist; and vast as is the power the national banks now wield, and well organized as is their opposition to the abrogation of their monopoly, there is but little doubt that it will be made, and that it will be as much for their own interest, in their legitimate banking business, as the advent of a similar democratic change has been found with the Bank of England, for its pecuniary benefit.

FURNITURE.

ANCIENT EGYPTIAN AND ASSYRIAN FURNITURE. — CABINET-MAKING AMONG THE GREEKS AND ROMANS. — FORTUNES ABSORBED IN FURNITURE. — DECLINE IN THE MANUFACTURE. — THE MIDDLE AGES. — ECCLESIASTICAL, OR DECORATED GOTHIC STYLE. — OLD-TIME FURNITURE IN ENGLAND. — REVIVAL OF THE MANUFACTURE. — FURNITURE IN FRANCE. — THE ROYAL MANUFACTORY. — LOUIS QUATORZE STYLE. — INTRODUCTION OF MAHOGANY IN ENGLAND. — VENEERS. — FRENCH FASHIONS IN FURNITURE. — CABINET-MAKING IN THE COLONIES. — ECONOMICAL STYLES. — MAHOGANY AND ROSEWOOD. — USE OF NATIVE WOODS. — BLACK WALNUT. — IMPORTED FURNITURE. — RAGE FOR OLD STYLES. — IMITATIONS. — CHAIR-MAKING. — CONVICTS AS CHAIR-MAKERS. — OFFICE AND SCHOOL FURNITURE. — DINING-ROOM AND CHAMBER SETS. — EXTENT OF THE INDUSTRY IN THE UNITED STATES.

THE term "furniture," which means nearly every article and utensil of household use, is so comprehensive that it includes many things which have been described in detail elsewhere in this volume. The present article proposes to give a general description of what is sometimes called "cabinet ware," and some account of the progress of this branch of manufacture in the United States.

Household furniture, of a rude description, dates back to the time when men began to build houses to live in. The monuments which remain in Egypt and Assyria give abundant representations of the conveniences of ancient households in those countries; and in times which antedate all written history, if the king had his throne the subject had his chair. It is known, too, that the ancient Egyptians had in their houses, not only such articles of use as tables, chairs, and couches, but that in the residences of the rich, these pieces of furniture were made of the rarest woods, with costly carvings, and inlaid work of gold and ivory. Their apartments were hung with elaborately-wrought tapestries, and similar woven work covered the seats, and backs of chairs, and settees. What we know now as the "camp chair," in which the seat of cloth, carpeting, or leather permits the folding up of this

piece of furniture, is only a revival of a style which was common as long ago as men used the skins of animals for chair seats. Our cane-seat chairs are an adaptation from the times when strips of leather were interlaced for the same purpose. Long before the days of the first Pharaoh the Egyptians had carved couches, bedsteads of iron, and, it is believed, of bronze. Carpets were on the floors of the wealthy. They had metal mirrors, and a great profusion of kitchen utensils, and dishes of all sorts for the table.

The Assyrians were not at all behind the Egyptians in the profusion, convenience, ornamentation, and elegance of their household furniture, and from them, through the Asiatic Ionians, the Greeks derived the art of furniture-making. From the Athenians the Romans took their first lessons, and soon wonderfully elaborated the art. The couches upon which the old Romans reposed at table were often inlaid with silver, gold, ivory, tortoise-shell, and precious woods, with carved ivory or metal feet ; and the furniture of a rich man's house represented in itself an enormous fortune. The discoveries of actual furniture at Pompei show what was considered essential to a luxurious Roman household centuries ago.

The art of making elaborate furniture seems to have been lost, or the changes in civilization and in individual fortunes destroyed the demand, for, from the year 500, for a thousand years, there is scarcely anything to indicate the prevailing style of furniture, excepting what is shown in illuminated manuscripts, as representations of what was used in the churches and monasteries. Undoubtedly the ecclesiastical, or decorated Gothic, was the style for some centuries in the houses of the wealthy, as it was in the cathedrals, convents, monasteries, and public buildings. The common people of Europe, no doubt, were content with the rudest stools, tables, and bedsteads. Up to the fifteenth century, in England the household furniture was of the roughest and most cumbrous description. The heavy chairs, backed benches, or "settles," were generally fixtures to the floor or against the wall, and in old baronial halls the tables were often plain boards, resting upon trestles. From the fifteenth century there was a marked improvement for several years, both in the construction and convenience of articles for household use. Fires were no longer built on the hearth, but the logs were piled up on andirons. The ornamented furniture, long in use on the continent, was to some extent copied in England. Clocks and musical instruments began to ap-

pear in houses. Tapestries, panellings, carved bedsteads, chairs, chests, and cabinets were introduced; but for many years the amount of furniture, even in the houses of the wealthiest people, was very scanty. It is somewhat singular that in the much-boasted Elizabethan era, when literature, and, to some extent, even art flourished, furniture-making degenerated; and the remains from that period show clumsy, uncouth articles, devoid of taste, and oftentimes positively inelegant.

The reign of Louis XIV., in France, gave an impulse to house decoration, which brought cabinet-making well within the domain of real art. Colbert, his minister, assembled in Paris the best cabinet-makers in Europe, and the work from the royal manufactory speedily obtained a great celebrity. The famous "buhl work," which really was a revival of a style known to the Romans centuries before, and which consisted of inlayings of shell, porcelain, enamel, ivory, gold, silver, and bronze, owes its perfection and popularity to the French royal manufactory. In the reign of Louis XIV.'s successor, Louis XV., the work was still carried on, and some advance in the art was made, though pieces of furniture made in the previous reign still command, when at rare intervals a choice specimen is offered for sale, the almost fabulous prices which attach to the rarest works of the old painters. This era in French furniture-making founded a style which is still popular abroad, and which prevails in the United States to an even greater extent, perhaps, than in Europe.

In England, under the reign of William III., the use of native woods, like oak and chestnut, began to give way to mahogany, and the sombre character of this wood seems to have inspired the heavy, inelegant designs which distinguished the furniture of England for a long period, and which came to the colonies in this country with the earliest settlers. Indeed, it is only within a few years that mahogany has been superseded by other more appropriate and even richer woods. The chief charm of mahogany must have been in its cost; but the rich old solid furniture was rare, while everywhere in England and America there was an abundance of veneered abominations, in the form of "mahogany" cabinets, secretaries, desks, tables, chairs, bureaus, piano-cases, etc., and in many parts of the country this style of showy, but cheap, and probably veneered, furniture, still prevails, and is even popular, to the exclusion of really richer furniture, solidly made from less expensive native and foreign woods.

Since the foundation of the royal manufactory in Paris, France, without doubt, stands at the head of all nations in furniture-making, and in furnishing furniture models and fashions for the rest of the world. Since Louis XIV., every monarch in France has encouraged the art, and what has come to be known as the Louis Quatorze style, is the prevailing one still among people of taste everywhere. Very great advances have also been made in the manufacture in England in the present century.

Some of the furniture brought over by the settlers at Jamestown and at Plymouth is still extant; indeed, if the "Mayflower" brought over all the old chests, bedsteads, chairs, and bureaus, which are said to have come over in that vessel, she must have been as large as the "Great Eastern." For the first few years after the settlement of the country all the best furniture — generally of mahogany, though sometimes of oak — was imported. Among the first pieces of furniture made in this country were such economical devices as seats that could be turned into tables, and tables hinged against the wall, so that, when not in use, they could be turned down, thus giving more room in an apartment; and the same economizing of space suggested the once very common dining table, with leaves turning down — a style nearly superseded at present by oval tables, in which leaves can be inserted to lengthen the table for the number of guests who are to sit at it. After a while our West India trade led to the importation of mahogany, which was worked up solidly, or in veneers, into high-backed, uncomfortable chairs, tall, four-feet bedsteads, huge bureaus and sideboards, which were enormous closets for the storage of plate, dishes, and wines. Then came rosewood, from the West Indies and South America; and with those who could afford to purchase it, furniture made from this beautiful material speedily became popular.

For more common furniture, oak, pine, cherry, maple, and chestnut were, and still are, freely used. Of late years black walnut, one of the most beautiful of the native woods, has become almost universal for the highest-priced, as well as the cheaper, styles of furniture. This wood is worked easily into the most elaborate forms and exquisite carvings, and the finer specimens of cabinet ware are finished by oiling, instead of varnishing, the oil bringing out the rich grain of the wood, which grows darker and handsomer by age. Chestnut is also much used for dining-room and chamber sets, and the material is beautiful, as well as cheap and abundant.

For wealthy people in the large cities, like New York, Philadelphia, and Boston, a great deal of costly foreign furniture is imported, and foreign styles are adopted by many of our manufacturers. In certain specialties, however, such as office and school furniture, and in chair-making, the American cabinet-makers surpass all others. Chairs, made from maple, beech, and other native woods, with India rattan split and woven seats, almost the entire process being conducted by steam-propelled machinery, are made by thousands of dozens in several large manufactories, and are distributed, not only throughout the United States, but by exportation to all parts of the world. This branch of manufacture is carried on by contract in several of the prisons and penal establishments in the country, and it is a very important American industry.

Very beautiful enamelled furniture, especially for chamber sets, is extensively manufactured. The rage for old furniture not only occasions a demand, at most extravagant prices, for genuine articles of undoubted antiquity, but has led to a revival of some old styles, and to very successful imitations. Probably the black walnut work of the United States cabinet-makers is not surpassed in beauty of designs and perfection of finish elsewhere in the world, and at present furniture from this wood seems to be the prevailing style.

Cabinet-making is extensively carried on in every important city in the United States, and some of the larger establishments employ from five hundred to a thousand men, and work up from four millions to eight millions of feet of lumber every year.

CHEMICAL MANUFACTURES.

THE PROGRESS OF MODERN GENIUS IN MECHANICAL PURSUITS. — CHEMISTRY PRACTICALLY APPLIED TO AGRICULTURE OF LATE DATE. — A TRIUMPH GRANDER THAN THAT OF MECHANICS. — BARREN SAND-FIELDS MADE TO BLOSSOM AS THE ROSE. — A GRATIFYING SPECTACLE. — PROFESSOR EBEN N. HORSFORD AND MR. GEORGE F. WILSON, AND THEIR GREAT WORK. — THE SAND-PLAINS OF SEEKONK. — THE RUMFORD CHEMICAL WORKS NEAR PROVIDENCE, R. I., AND THEIR VARIED AND IMPORTANT PRODUCTIONS. — WILSON'S AMMONIATED SUPERPHOSPHATE OF LIME, AND THE MAGNIFICENT RESULTS OF ITS USE. — HORSFORD'S CREAM OF TARTAR. — THE GREAT FERTILIZED FARM BELONGING TO THE RUMFORD CHEMICAL WORKS. — SUGGESTIONS TO THE PURCHASER OF FERTILIZERS.

Modern progress in the invention and construction of machinery for the saving of manual labor in the accomplishment of purposes which man's advance in science and art has made necessary to his happiness, marks a wide difference between the present status of the race and that which it occupied only a few hundred years ago. We know of nothing that the ancients accomplished for the benefit of mankind which will bear a comparison with the results attained from the labors of Watt and Fulton, and Franklin and Morse, and Stephenson and Bessamer, and many others, their contemporaries. Of not less value to the world, though less apparent, perhaps, have been the labors of those who have chosen to toil in the field of chemistry. Who can estimate the value of the discoveries which gave powder, and the acids, and the alkalies, and the metals, and a knowledge of their compounds to man?

But when we compare the knowledge which the ancients, whose history has been familiar to us, possessed, concerning the means of maintaining and increasing the fertility of the soil, so as to make it keep pace with the increasing demands made upon it by an ever-increasing population, with what is now known on that subject, a still more marked difference between the ancient and the modern becomes apparent.

Grand as the mighty workshops of the nation are, — the stupendous steam-engine factories, the palatial manufactories of cloths,

the immense machine-works, the vast warehouses teeming with the triumphs of mechanical labor, and the railways with their immense burdens of freight moved by gigantic engines,—grand as all these are, and more, they are practically of trivial importance compared with the great life of a nation which lies in the warming bosom of its soil, out of which the means of its existence must come; for if this be barren, the nation must crumble to decay, its workshops tumble to the ground, and the very railways and highways grow up with weeds. Human life depends upon the fruits of the earth, and they are the result of man's knowledge and skill, and long labor, watchfulness, and tender, weary care. When one beholds fields, where but yesterday was barren sand, yielding at best only the lowest species of cold moss, made rich, not by the adventitious aid of manures speculatively scattered upon them, but by the regular processes of science and art, beginning with an intelligent conception of what is needed, and step by step proceeding to its accomplishment without hesitation, speculation, or doubt, with sublime trust in the forces of nature, then is it that the mind rises to the lofty conception of things grander than mere mechanic art, however great, has accomplished.

One of the most gratifying scenes to be witnessed in all the wide world is presented to-day upon the once barren portion of that district of uninviting lands known as Seekonk Plains, situated about three miles east from the city of Providence, R. I., where Professor Eben N. Horsford and Mr. George F. Wilson have not only founded one of the largest chemical establishments in the world, but have made the once parched and barren fields of sand teem with richest grains and smile with the most luxuriant grasses. Throughout the whole land the writer has seen no spectacle equal to this, the result of man's working in accordance with the laws of nature. Here are situated the chief of the famous "Rumford Chemical Works," which manufacture Horsford's Cream of Tartar, Horsford's Bread Preparations, Yeast Powders, Bluing and Blacking, Bone Coal, Paper-makers' Colors, mineral acids, mordants of tin and iron, and fertilizers for grain and tobacco, or Wilson's Ammoniated Superphosphate of Lime and Wilson's Tobacco-Grower. But before entering into detail upon the manufactures of these great works, let us dwell for a time upon the men who have established them.

In January, 1855, Messrs. Horsford and Wilson entered into partnership for a purpose which is best expressed, perhaps, in one

clause of their agreement made at that time, and which is somewhat quaint for these modern days, and well worthy of record here. This clause declares their purpose to be that of "building up a chemical manufacturing establishment of respectability and permanency, such as shall be an honor to ourselves and our children, and a credit to the community in which it is located, and which shall afford us a means of reasonable support." Probably these earnest gentlemen had only a faint conception of the grandeur to which their talents and energy would elevate their enterprise within the space of a few short years. Mr. Horsford was then Rumford Professor in Harvard University, having before been Principal of a female academy in Albany, N. Y., his native State, and having also studied for several years in Germany under Baron Liebig, the great chemist and naturalist. In honor of this Professorship and of its founder, Count Rumford, the works took their name. On his return from Germany, the Hon. Abbot Lawrence was induced by his influence to lay the foundation of the "Lawrence Scientific School," a department in Harvard University devoted to instruction in the application of Science to Art. For nearly twenty years he filled the chair of chemistry in this institution, and during that time it enjoyed a reputation and success scarcely equalled since his resignation of the post. Mr. Wilson is a native of Uxbridge, Massachusetts, and a lineal descendant of Roger Wilson, who left Scrooby, England, with the Pilgrims in their migration to Leyden. Roger Wilson undoubtedly transmitted much of his sterling intelligence and force of character to his descendants, Mr. George F. Wilson bearing in his person the evidences of a robust and unconquerable stock. Roger Wilson was a silk and linen draper, a man of wealth, and was the bondsman for the only men among the Pilgrims who ever obtained the freedom of the city of Leyden, — Governor Bradford, Isaac Allerton, and Deggory Priest; and it is recorded that the fitting out of the Mayflower was greatly due to his liberality and enterprise.

Mr. Geo. F. Wilson was reared upon a farm, and learned how to perform well every part of farm work; but his leisure was devoted to useful reading and study.

At the age of seventeen it was decided that "George should learn some trade," and he selected that of wool sorting and stapling. When asked why he chose that, his reply was, "That kind of work cannot be done in the night, and I shall have all the evenings for study." They were not misimproved. The justice of the

father required of the son, not only a strict account of his earnings, but, excepting what was expended for clothing, the earnings also. Yet books must be had, and they were earned by extra labor, and mastered by extraordinary care and study.

At the end of an apprenticeship of three years, he was not only master of his trade, but of every machine in the mill, — drawings of which he made, — and he left his employers, receiving from them their recommendations and a valuable testimonial for faithful services, and entered, for the purpose of training and discipline, upon a course of alternate study and labor.

In 1844, he established the Chicago Academy, of which he was Principal, opening it with three pupils, and leaving it, in a little less than four years, with two hundred and twenty-five, and many applicants in advance for admission. While thus engaged, he made several important discoveries in illumination and concerning the effect of heat upon oils susceptible of use for that purpose. He was not unmindful of the probable future of Chicago, and did much by his collection of statistics, by his writings, and by personal effort, towards securing the commencement of her first railroad. Considering it time to engage in business pursuits, he sold out his school and valuable chemical and philosophical apparatus, and turned his face eastward, to the field of manufactures.

After filling several important business positions in the service of others, his studies having led him to a love for chemistry, he proposed, in 1854, to Professor Horsford, the formation of the copartnership to which we have before alluded, which being accepted he commenced the manufacture of chemicals at Pleasant Valley, Rhode Island.

These two able and scientific men thus coming together have wrought out for the world and for themselves problems in practical science and art hardly equalled by the studies and labors of any other two men to be found in the whole world.

In 1858 the Works, then considerable, were removed from Pleasant Valley to what is now known as East Providence, Rhode Island, but which was then Seekonk, in Massachusetts. Prosecutions were foolishly carried on by some of the inhabitants against the Works as a nuisance, but these were eventually ended by the settlement of the boundary line between Massachusetts and Rhode Island, which Mr. Wilson and his friends had vigorously pushed on to its issue, and by which the westerly portion of Seekonk, on which are situated the Rumford Chemical Works, became a part of Rhode

Island. Thus were the complaints under the Massachusetts law quashed, and Rhode Island gained one of the most important of her manufactories, while she has nothing of which she may more properly boast as more valuable to the well-being of the race in general. Before Mr. Wilson entered upon Seekonk Plains they were a synonyme, and had been for generations, for barrenness. A goodly portion of some eight hundred acres now owned by the Rumford Chemical Works is very prolific, the result of judicious cultivation and of the liberal use of the fertilizer known in the market as Wilson's Ammoniated Superphosphate of Lime, made at the "Riverside Works" of this company, founded in 1863, where the primary processes in the manufacture of cream of tartar are also conducted. At these Works the visitor may, early in the season, see a hundred thousand dollars' worth of this unequalled fertilizer in one vast pile, destined to be sent to various parts of the country to work its miracles in the promotion of vegetation.

When Mr. Wilson first removed to Seekonk Plains they presented to an ordinary observer few or no attractions for any purpose whatever. But his eye saw in the barren waste cheap building-sites and rich gardens, busy commerce in idle wharf-sites, rapid and cheap transportation in a railroad then but half occupied, ample power and wealth in an abundance of pure water, (the latter a consideration of no little importance to the Works he had determined to build,) and last, but not least, health in the pure atmosphere of the elevated plain.

His first purchases of land were made for twenty dollars an acre. The last purchase of adjoining barren lands was made at two hundred dollars an acre, so greatly had the proximity of the Chemical Works increased their value. Thus the progressive efforts of Messrs. Horsford and Wilson in the line of human advancement have promoted the welfare of those by whom they were at first prosecuted, and the bread which they cast upon the waters has returned tenfold by the increased value of their lands.

Here the farmer, desiring to increase the fertility of his soil, has but to look about him at the results produced and the profits reaped by the use of a thoroughly tested and conscientiously made fertilizer, to be convinced that the worst acre of ground upon the earth, if it be not of solid rock, may be made as prolific as the richest acre of prairie land. Here also he may see some of the best cattle and sheep to be found in the country fed upon the crops now grown upon these once barren plains. Mr. Wilson may well

take great pride in his stock, though, to use his own expression, "he has but just begun to improve it," for they are the offspring of the best imported as well as domestic breeds. A visit to Seekonk Plains and the Rumford Chemical Works' farm is well worth the while of the traveller from any quarter of the globe, especially if he takes delight in the triumphs of genius and skill over the perversities or ruggedness of Nature.

In New England he would be called a *large* farmer. From the following, some idea of his farming operations may be obtained. Number of acres this year in corn, 35; in potatoes, 40; in barley, 14; in rye, 32; in oats, 32; millet, 45. In soiling crops, 10; in carrots, beets, and turnips, 10. Fall seeding to grass, 90. In grass, 175; number of acres under cultivation, 500, — including the pastures.

The Works and farms employ thirty horses and thirty-six oxen, and keep one hundred and fifty hogs and fifty head of young cattle. Fifty cows are milked, and the milk is converted into butter and cheese in one of the best of dairy-houses, provided with steam-power and hot and cold water. Twenty-five thousand pounds of pork and eighteen thousand pounds of beef, of his own raising, will be slaughtered *in his own slaughter-house* this year. Nearly all of this produce is readily sold to the employees of the company.

To secure and store these crops, thirteen hundred feet in length of barns and cribs, and three hundred and fifty feet of sheds, have been provided. The grain is threshed and fodder cut with steam-power, and the food for both cattle and swine is cooked by steam, and in the boiler-house is a steam fire-pump and hose, capable of throwing water over many of the farm buildings.

The principal manufacture at the Rumford Works, so distinguished from the Riverside Works, is that of pulverulent phosphoric acid, commonly known as "Horsford's Cream of Tartar," for bread-raising. In the invention of this chemical, the main desire was to avoid all fermentation, and to give to bread made of bolted flour a deficient ingredient which would add to the nutritious quality of the bread.

Of all the salts taking part in vital processes, the most important are the phosphates. They enter into the composition of the bones, the muscles, the nerves, the brain, and indeed of every higher tissue; and wherever an important function is to be performed, there Nature has supplied a store of phosphates. They are present

in all substantial food. The medical faculty are now paying great attention to preparations of phosphatic salts; and for debility, and especially for diseases of the brain, they are constantly administered. The whole tone of the system is lowered by a diet deficient in the phosphates, and is raised by food containing a large proportion of them. As is well known, in the preparation of superfine flour the normal quantity of the phosphates is largely decreased in consequence of fine bolting, the bran containing weight for weight more than *fourteen times* as much phosphoric acid as the superfine flour. In this way the flour is deprived of one of its most important elements. In order to secure the phosphates, it is recommended by physicians that unbolted or Graham flour be used, but unfortunately it soon becomes sour; and to dyspeptics the superfine flour is prohibited If, then, we can get back the phosphates which have been so uselessly thrown away, we shall be doing a service to the general health. This is precisely what this manufacture does, as will be seen by following one of the processes.

The raw material is secured by agents all through the United States, who buy the beef-bones which until within a few years, as a rule, have been wasted. These bones are distilled in closed iron retorts. The coal is ground and bolted. The coarser sorts are sold to the sugar-refiners. From the next two sizes acid phosphate of lime is extracted for the manufacture of cream of tartar, and the finest is used for making superphosphate of lime. The coal employed in the manufacture of cream of tartar is subjected to another burning in an oven, into which air is admitted, and, after being cooled, is combined with sulphuric acid, and stirred by machinery for eighteen hours, until the bone coal is thoroughly dissolved. The mixture is then drawn off and leached through thick felt, the acid phosphate of lime coming out a colorless fluid, the residuum, phospho-sulphate of lime, being used with soft bones in making superphosphate. The acid phosphate is evaporated in porcelain-lined iron kettles, the process occupying from seven to nine hours. It is then poured into vats, and when cooled it is of the consistency of cheese. It is now mixed with pure starch. This mixing is first done in the vats, and then it is run through granite rollers for more perfect comminution and combination. Then it is taken to the drying-floor and spread, and allowed to remain from eight to ten days, when it is again subjected to heat, the more perfectly to dry it. Again it is ground, bolted, and put in packages for market. It will be seen that the use of this article in making bread supplies

to a certain extent the phosphates lost in the excessive bolting of our superfine flour.

The buildings at Riverside are, first, —

One where the bones are burned	125 × 45 feet
Storehouse	132 × 64 "
Storehouse and cooper's shop	85 × 30 "
Superphosphate-of-lime building	120 × 50 "
Store shed	175 × 16 "
Slaughter-house	30 × 16 "
One in process of erection	120 × 80 "

in which is to be manufactured nitric and muriatic acid and tin crystals.

RIVERSIDE.

The buildings at the Rumford Works are, —

One	220 × 40 feet
One	172 × 40 "
One	153 × 40 "

in which the different processes of manufacture are carried on;

Freight house	135 × 26 feet
Storehouse and blacksmith's shop	180 × 20 "
Store shed	100 × 20 "
Office and store	55 × 25 "
Barn	36 × 32 "
Barn	105 × 36 "
Carriage and wagon house and shed	150 × 25 "

and dwelling-house, — the whole closely occupying an area of nearly eight acres. To accommodate the business, two switches have been constructed from the Boston and Providence Railroad, and another is building for the use of the new and large buildings which are needed.

RUMFORD.

At the Riverside Works a steam-engine of forty horse-power is in use, and fifty men are employed; at Rumford three engines having sixty horse-power are used, and eighty men are employed. Both works give employment, in addition, to forty mechanics, and on the farm there are forty laborers, and more are engaged during the summer. The preparation of the cream of tartar for market is done in Providence, where the company occupy a large building 64 × 64 feet, of four stories, Nos. 58, 59, 60, on South Water Street. Here are employed forty-five girls and eight men. To do the printing necessary for the business, three printing-presses are used, one of them the largest single-cylinder press in the State. The printing would cost at regular rates some twenty thousand dollars annually. This department of the business will soon be removed to the Rumford Works.

The quantity of the several productions yearly made is nearly as follows: —

Cream of Tartar	1,200,000 lbs.
Superphosphate of Lime	3,000,000 "
Tobacco-Grower	1,000,000 "
Bone Coal	3,150,000 "
Sulphate of Ammonia	300,000 "

Antichloride of Lime	200,000 lbs.
Nitric Acid	350,000 "
Muriatic Acid	400,000 "

and the quantity of Oil of Vitriol consumed in the works is not far from 1,500,000 lbs.

One of the most rapidly increasing and important of their productions is "Horsford's Acid Phosphate" (medicinal) for the cure of diseases of the brain and nervous system, for dyspepsia or indigestion, and urinary difficulties. Many of the leading physicians of the land have given it their unqualified approval.

Mr. Wilson for twenty years past has been more or less persistently engaged in the attempt to make a good black writing and copying ink, and, having succeeded to his satisfaction, has erected apparatus and machinery for making one thousand gallons per day. He makes the best boot and shoe blacking and puts it in the best box (both covered by patents) to be found in the country. It is his aim that every article, however unimportant, made in the works, shall be of the very best quality, so that the brand of the works will be the only guaranty of excellence which the consumers will ask for.

In this view he is fully sustained by his partner, Professor Horsford, who, though not actively engaged at the Works, is fully alive to their interests and welfare.

But to return to Seekonk Plains. The reader has seen what marvels the genius of scientific men is competent to accomplish; but when Mr. Wilson had raised large crops of grass and corn, it was said "well he might, he had a mine of manure in superphosphate which he could apply without regard to cost." Now the fact is that his farms are platted into lots, and with every lot a correct account is kept, and to every lot is charged the labor, the manure, and fertilizers put thereon, at the market price, thus showing the gain or loss in the operation performed on it. The same is true of every article made in the works. Every department is under the charge of a competent foreman, who is held accountable for the prompt discharge of the duty assigned to him. But we do not propose to go into further detail, and we have alluded to the success of the farm because the latter serves as a wondrous exemplification of the value of the fertilizers made by the Rumford Chemical Works. We ought not to leave this part of our subject without apprising our readers that many fertilizers which are nearly worth-

less, containing but a small portion of ammonia and superphosphate of lime, are placed by unscrupulous manufacturers upon the market. And though we would avoid in a work of this kind anything bearing the semblance of prejudiced praise or selfishly interested esteem, we deem it not unfitting to say that so great was the enthusiasm of the writer on paying a personal visit to the Rumford Chemical Works, studying the processes there conducted, and looking over the rich acres there produced from the barren plains by the use of the fertilizers made by these Works, that he felt it a duty to the reader, and so made special remarks in his "notes" taken on the occasion in question, to say to him, that, in order to avoid all possibility of being defrauded in the purchase of his fertilizers, he should take care to first try the Ammoniated Superphosphate of Lime made by the Rumford Chemical Works before purchasing other productions, however well recommended. For the cause of real science, and with benevolent respect for the farmer or other reader who seeks to inform and benefit himself through the pages of this work, we could hardly avoid adding the above caution.

The same may be said of their other manufactures, and no better evidence of the truthfulness of the remark can be called for than the facts, that, notwithstanding the extraordinary growth of the Works from a beginning so small that one horse and wagon could do all their transportation, they have never been able to keep pace with the demand for their productions, and that their fires since 1854, the commencement of the business, have never been out.

We have thus far spoken of the farms and of the Chemical Works proper, but they are by no means the only business Mr. Wilson has in hand.

In 1863, he accidentally discovered several large deposits of peat, and finding they could be drained, he at once set about their possession. This was accomplished after two years of patient waiting, and after four separate purchases of land amounting together to more than three hundred acres. He immediately dug what some persons called a "Dutch Gap Canal," drained the bog seventeen feet deep, and now quietly takes out the peat, while they "gape" in astonishment to see how easily it is done. There are not less than 150,000 cords of peat in the deposits, and what is sold brings two dollars per cord in the bog.

With machines for its manufacture, driven by steam-power, there is annually produced several hundred tons of fuel, which is consumed in the Works, being worth more, for some purposes, than coal at the

same price per ton. The peat is carried to and around the drying ground from the machines on a narrow-gauge railroad, (in which Mr. Wilson is a firm believer,) the first constructed in New England.

Before and during the Revolutionary War, and down to 1836, when anthracite coal took the place of charcoal in smelting-furnaces, the best quality of iron was made from Rhode Island iron ores.

Six months ago, an iron-founder from Pennsylvania laid before Mr. Wilson some new plans for making iron from these ores, and for its subsequent conversion into steel and steel rails.

A careful investigation convinced him that the processes were worthy of trial. The next day he selected a site upon tide-water, easily accessible by railroad, bought it, built the works, and at this writing, less than six months from his introduction to the inventor, he has steam up in the boilers, and fires in both furnaces preparatory to charging them with the ores.

A few weeks will decide the success of the plans. If successful, there will be no want of capital to enlarge, to any extent, the enterprise.

He also has a manufactory in Providence, which will, erelong, be removed to East Providence, where the best spinning-rings, ring-travellers, belt-fasteners, spindle-bolsters, and spindle-steps, and creel-steps, now in use, and which are rapidly superseding all others, are made.

Should Mr. Wilson's life and health be continued, there is little doubt that the place he has chosen for his home will well deserve the name already given to it, for the future, by an old friend of his, (Harvey Chace), the *Clyde of America.*

THE POST OFFICE.

THE IMPORTANCE OF THE POST OFFICE. — THE NEEDS IT IS INTENDED TO MEET. — THE ORIGIN OF THE POST. — THE ROMAN SYSTEM. — THE IDEA OF A PUBLIC POST PECULIARLY MODERN. — CHARLEMAGNE'S POST. — THE POST IN FRANCE. — IN ENGLAND. — THE MODERN SYSTEM INTRODUCED IN TYROL. — THE FIRST REGULAR MAIL BETWEEN LONDON AND EDINBURGH. — JOHN PALMER AND HIS IMPROVEMENT. — ROWLAND HILL AND THE IDEA OF CHEAP POSTAGE. — MONEY ORDER SYSTEM. — POST OFFICE SAVINGS BANKS. — INVIOLABILITY OF THE MAILS. — THE POST OFFICE AMONG THE COLONIES. — BENJAMIN FRANKLIN, POST MASTER. — THE FORMER RATES OF POSTAGE. — SUGGESTIONS FOR THE FUTURE OF THE POST OFFICE.

Among the various public organizations, which in our modern civilization serve to express and to increase the activity of our social and industrial life, the post office holds a most prominent position. It serves to bring those who are divided into easy and reliable communication ; it gives a voice to the body politic ; it serves for the ready transmission of intelligence, and is one of the most effective agencies in producing the sentiment of unity and mutual sympathy, which, as a result of our common social nature, always springs up between men who meet and commune together, freed from the artificial isolations of convention or prejudice, upon the universal plane of their common humanity.

With the invention of the art of writing, as a means of communication with each other, men, of course, felt the need of some method for sending their letters to their destination ; and among the Assyrians and Persians, from the earliest times of their history, we find that these governments had organized a system for the dissemination of their edicts and orders to the subordinate officers in distant parts of their empires by messengers, who were stationed a day's journey from each other. Among the Romans government despatches were sent by horsemen, mounted on swift horses ; and the extent of the Roman Empire made the system of the post for this purpose an important public necessity, and was

one of the chief causes which led to the improvement of the roads, and the construction of the level and solid highways, which are still the envy and admiration of the moderns in many parts of Europe. The regularity and safety with which the government despatches from Rome were sent to their various destinations, led soon to the use of the public messengers by private persons, who could obtain the opportunity to send their letters to personal friends by this means. Though letters were frequently so sent by persons in authority, or connected in some way with the government, yet, in the modern acceptation of the word, there was in the Roman Empire nothing like our present post office, or public post, by which letters are received from any one desirous of sending them, and for a small charge distributed all over the country.

The first introduction of this great convenience to the public belongs to the modern world, and is said to have been organized by Charlemagne, who instituted a regular post in his dominions for both letters and small parcels. With the dissolution of his empire, after his death, the system fell into disuse. It required at that time the strong rule of such an autocrat as Charlemagne to introduce and maintain it, and the disintegration, after his death, of the empire he had formed, with the consequent retrogression into the isolation and darkness of the middle ages, destroyed the general demand, and the ability to make use of such a measure for social organization.

In 1464 Louis XI. stationed posts, four miles apart, over France for the transmission of despatches from the government. In England, during the thirteenth century, a somewhat similar arrangement was made for the same purpose, the messengers of which were called *nuncii*. But the inefficacy of this organization to meet the public need, even at that time, for the convenience of a post office, was shown by the fact, that the butchers and drovers, who, in quest of a market for their stock, were accustomed to wander periodically through the country, were, as late as the fifteenth century, the chief dependence of the public for the distribution of private letters in England, and that private letters were not carried in the public mail until the sixteenth century.

Upon the continent, as early as the eleventh century, the University of Paris, to which hundreds of young men gathered yearly from all parts of Europe to obtain the education there offered, had established a kind of post by which they could communicate with their homes, and receive, through trustworthy messengers, the re-

mittances of money which they needed for their support. None of these various attempts can, however, be considered as instances of the establishment of a public post, which was open to all the public, and performed its functions with despatch and regularity, though the needs they were intended to supply showed that there was a demand for some postal system, and they all aided in increasing the demand for some method to subserve the increasing desire for intercommunication, which is so distinguishing a sign of an advancing social organization. The first arrangement made in Europe, which can be called a public post, was instituted in 1516, by Roger, Count of Thurn and Taxis, who established, in Tyrol, a post by which letters were transmitted regularly between Germany and Italy. The relations between these two countries were very intimate at this time, and the profits of this enterprise were so large that they formed an important part of the royal revenue, and remained in the hands of the successors of Count Roger until the fall of the German Empire, and, in a measure, this private monopoly of the public post is still held as a family possession by the descendants of its originator.

In 1524 the French post first carried other letters than those written by the king or by members of the nobility. In England, James I. established the first post which ran regularly between London and Edinburgh, the capitals of England and Scotland.

The speed with which they travelled may be estimated from the fact that it required six days to go and return — three days from one point to the other. In 1644 the first weekly post was established to all parts of England, from London.

In 1784 the rapidity with which the mails were disseminated was greatly increased by the introduction of swift mail-coaches. Their average rate of ten miles an hour was considered at the time wonderful. The method in use for the transmission of the mails, before this reform was introduced, will be best shown by an extract from the memoir submitted to Mr. Pitt, in 1783, by John Palmer, with whom the idea of the improved system originated. "The post at present," he writes, "instead of being the swiftest, is almost the slowest conveyance in this country; and though, from the great improvements in our roads, other carriers have proportionately mended their speed, the post is as slow as ever. It is likewise very unsafe, as the frequent robberies of it testify; and to avoid a loss of this nature, people generally cut bank bills, or bills at sight, in two, and send the parts by different posts. The post-

master general lately advertised directions to the public how to divide a bill in such a manner as to prevent its being of any use to the robber. Rewards have also been frequently offered by him for the best constructed mail-cart, or some plan to prevent the frequent robbery of the mail, but without effect. Indeed, it is at present generally intrusted to some idle boy, without character, mounted on a worn-out hack, and who, so far from being able to defend himself, or escape from a robber, is much more likely to be in league with him."

When it is remembered that at this time — less than a hundred years ago — the mail out of London, containing the letters of the merchants and bankers of that metropolis, consisting often of enclosures of hundreds of thousands, if not of millions of pounds, was daily intrusted to these post-boys, who carried them in bags slung over their horses necks, some estimate can be formed of the advance in this department of social organization which has been made during the existence of three generations. The chief mail at this time left London at midnight; an arrangement which, in the unlighted condition of the roads, was not calculated to increase the safety of the mail.

In 1837 Rowland Hill, who has justly earned his reputation as a benefactor of the race, proposed the system of cheap and uniform postage which now prevails in England. Despite the ridicule and incredulity with which the suggestion was at first received, he persevered, and in 1839 the proposition was accepted by Parliament, and went into operation in 1840. At first, as previously, the postage was all prepaid in money, but soon after the use of stamps was introduced.

The English government, at a very early period of the cheap postage era, introduced the money-order system, which had before prevailed in Germany. By this means money can be sent in post-office orders, without any fear of loss, and at a very reasonable charge. The great convenience introduced by this measure, for the safe transmission of money in small quantities, was, about ten years after, supplemented by the still greater convenience of making the post office a savings bank, conducted by the government, in which every office throughout the country was a place to receive deposits. The advantages of this system, which are equally great for the public and the government, were immediately recognized, and made the English post office one of the most useful public institutions in the civilized world, and expressive of a more ad-

vanced condition of social organization than that of any other country. The economy of means with which it is carried on is not the least of its claims to consideration ; the force required for performing the duties of the post office, before it was introduced, being quite competent for the transaction of this new duty, with perhaps the addition of only a few extra clerks in some of the large towns. All throughout the country the village postmasters, who usually devote their entire time to the duties of their office, can easily, without finding themselves overtaxed, receive the money that is offered on deposit, and enter it in the depositor's passbook.

The organization of the system is complete. The government pays interest upon the money thus deposited ; that is, it does what the ordinary savings banks do with the money intrusted to them ; it simply purchases its own bonds with it, and can afford to pay the depositors a better rate than the savings bank which makes the same investment of the funds thus collected, because the government, being under no extra charge for doing this work, is not obliged to deduct any percentage of the interest to pay its own expenses. Besides, too, the money of the depositors, which is thus invested by the government in its own bonds, is safe beyond peradventure ; and that this fact is sufficiently evident to the depositors for them to appreciate it, is shown by the thousands of them who have yearly, since the adoption of this method, transferred their money from the savings banks to the government, while, by the last report, there had been found only one depositor with the government who had transferred his money to the savings bank.

Another immense advantage which this general system of the government offers the depositors, lies in the fact that the universality of the post office, and its unity of management, enables the government, without extra expense, to receive money at any office, and carry it to the credit of an account kept in any other office. Thus a depositor, who is travelling upon business, or for any other purpose, can deposit in any town where he may be any money he may collect, and have it carried to his credit in his home office, thus saving the risk of carrying it upon his person. In the same way also any depositor in a distant town can draw money from his deposit in his home office. In such cases the office reserves the privilege of waiting until, by telegraph or by mail, it can be assured from the home office that there is such a deposit; but in

practice, as all the transactions are entered in the depositor's pass-book, the production of this is in general considered sufficient evidence of the correctness of the application, and it is paid immediately in cash. No savings bank, and no private or corporate bank, can offer such advantages, since the charge they must make for such transfers, as it is a part of the legitimate business by which they live, the government, on account of its universality, can forego, since it is for its interest only to increase the amounts deposited with it by offering every possible advantage to the depositors.

In France, before 1791, the operation of the post was farmed out to the highest bidder; but in that year the government took its management, and organized the system which has prevailed up to this time. In France, and most of the other countries of Europe which are despotically managed in the interest of the rulers, the government uses its control of the post office as a means of espionage over its subjects, and does not hesitate to tamper with the letters intrusted to it for transmission. The sentiment of honesty, which would as soon justify the picking of another's pocket as the opening of his letters, is peculiarly the outgrowth of political freedom, and its strength serves to mark quite accurately the advance of a people in the course of democratic evolution which characterizes the present era of civilization, and the inviolability of the mails is as important a right of the people as that of *habeas corpus*, freedom from illegal arrest, the freedom of the press, or any other of the safeguards from despotism.

In the colonial history of the United States, the first post was projected in 1692, but did not go into operation until 1710. The thinly settled condition of the country, and the distance which separated the scattered towns along the coast, prevented the speedy growth of the post office. The social, as the industrial life of that time, did not demand the regularity and speed of the present day. In 1753 Benjamin Franklin was appointed by the English government postmaster general of the colonies, and, in 1760, astonished the people by proposing to run a mail coach from Boston to Philadelphia each week, starting one from each place.

Franklin held this position, and, by his practical talent for organization, did much to bind the colonists together by introducing regularity in the mail service, until his removal by the British government in 1774, on account of the leading position he took in the exciting times which led to the Revolution.

In 1789 the control of the post office was given by the Constitution to Congress, who thus, as the representatives of the people, have the regulation of this important branch of the public service. This is as it should be, and is in itself an evidence that the post office is not a privilege granted by some ruler to his grateful subjects, but a system organized by the people, through their agents, to whom they have delegated this authority for the transaction of such portions of their business as they think it best to intrust to it. The tendency there always is in those who have not arrived at the largest culture, but who are placed in positions of greater or less authority, to consider themselves masters, instead of servants or agents, has not been backward in expressing itself in this country in the post office, as it is also too generally displayed even in Congress itself, and in fact throughout the whole national administration.

The people of the United States are themselves hardly yet conscious of their power, and that the government obtains its authority from them, and is itself their servant. The traditions also of all other governments in the civilized world, and their influence as far as it is exercised in their official relations with our own, and in the personal relations of its representatives at Washington with the heads of our departments, tend to foster the autocratic spirit, instead of the democratic one, and to render the department often overbearing in its relations with the public, and much more prone to command than to obey. Evidences of this must have been made plain to every one who has in any way been brought into such relations with those holding responsible positions as would give an opportunity for its display; but with the increase of public culture the material is preparing for remedying this; and the various departments of the government will be forced into the practical recognition that the reason for their existence lies only in the performance of their functions.

In 1790 there were only seventy-five post offices in the whole country, while, up to 1816, the rates of postage were as follows: For any distance under forty miles, eight cents; under ninety, ten cents; under one hundred and fifty, twelve and a half cents. In 1816 a considerable change was made, placing the rates for distances under thirty miles at six and a quarter cents; under eighty at ten cents; and over four hundred miles at twenty-five cents, and these rates were quadrupled upon letters which weighed an ounce. Under these rates of postage, up to 1837, the expenses of

the post office were greater than the receipts, leaving a deficit every year to be made up from the public treasury. In 1845 the rates were again reduced to five cents for all distances under three hundred miles, and ten cents for all greater distances. In 1852 a further change was made, putting the postage at ten cents upon all unpaid letters for distances under three thousand miles, and in this same year the sale of postage stamps and stamped envelopes was begun. In 1855 the charge for letters was placed at three cents for all distances under three thousand miles, and ten cents for any greater distance, at which they have remained since. From the report of the department for 1870, it appears that the number of mail routes is 8861, traversing annually 97,024,996 miles, at a cost of $10,884,653.

The value and importance of the post office, as a disseminator of intelligence, and its worth in stimulating the activity of the social and industrial life of the nation, is fully recognized by the public, but not as fully by the department itself. The tendency of official personages to consider, in all questions of public administration, that they are conferring a favor upon the public by the performance of the duties of their office, and that the public has no further rights than they may graciously grant, has been shown chiefly in the spirit of the decisions made by the department upon various matters where the wording of the acts of Congress has been, as is too frequently the case, so ambiguous as to be confusing instead of distinct. A single instance will be sufficient. By the act, author's manuscript was transmitted through the mail at the rates of printed matter. This privilege, which was no appreciable loss to the post office department, was of considerable value to the writers of the country, who, as a rule, are not over rich, while to the public, in so far as it aided the intellectual life of the country, it was a matter of very considerable importance. This right, however, having been questioned, the department decided against it, showing, by the spirit of the decision, that the receipts of the post office were, in its opinion, a more important matter to be considered than the interest of the public. This appeared the more so from the fact that, though ambiguous in part, the wording of the act plainly indicated that the intention of Congress was to give the authors this right, since its importance for its effects upon the activity of the country's literature was evidently the chief motive for its passage.

The experience in Europe of the advantage to the post office of

the government control of the railways has been shown in the article upon Railroads, and is a subject which is naturally exciting attention, both in England and this coutry, among those who are interested in the study of social organization. With the transmission and the distribution of the mails, it has also been suggested that the post office should join that of the carrying of small parcels, thus removing from the hands of the express, which has monopolized it, this absolutely necessary convenience of our modern life. For this the present organization of the post office, with but a slight increase of force, is quite competent, and the benefit to the public would be great.

The success which has attended the introduction of the money-order system, which was a few years ago imitated from that of England, makes it more singular that the system by which each post office is made also a savings bank, which has met with such great success in England, has not before this been also imitated in this country. The wide extent of our territory makes it peculiarly fitted for the introduction of this reform. At present the majority of the villages are wanting in any institution where the savings of the people can be readily deposited, and kept until needed for use; and it is not too much to say that one of the results of the introduction of this system would be to absorb the savings of the people, which now lie idle for want of some handy place in which to place them, and that the amount which would thus be gathered in the hands of the government for investment in its bonds would amount soon to scores of millions of dollars, thus practically funding that portion of our national debt.

In October, 1871, the inauguration of the extension of the money-order system to foreign countries took place, with the arrangement by which Great Britain and Switzerland, with the United States, introduced an international post office money-order bureau. The convenience of this can hardly be overestimated. It is now, for the first time in the history of the world, possible to transmit, through the post office and at a slight charge, small sums of money to these foreign countries. Great as have been the changes introduced in our modern times in the methods of commerce and transportation, yet there is none which is more pregnant with beneficent results than this, which appears to have excited so little attention. It is, however, the germ from which in the future the system of the world's exchange will be organized in the interest of its industry, and the importance of this will be clearly seen when it is

remembered that the charge levied heretofore by the money-changers of the world, in the various centres of exchange, has made the wealth of all the cities of the past, which have risen with the changing course of trade. Nor is it rash to predict that in the future, by an extension of the method thus inaugurated, the world's exchange will be settled as easily and as cheaply as the balances of the banks of any commercial city are in the clearing-house, and, by an analogous process, in a world's clearing-house. In the organization of the world's industry, the necessity for some such result is becoming daily more and more apparent.

SPOOL-COTTON THREAD.

THE GREAT TRIUMPH OF THE THREAD-MAKER'S ART. — INCOMPREHENSIBLE FIGURES. — THE DISTAFF. — THE OLD SPINNING-WHEEL IN THE TIME OF HENRY VIII.— SCIENCE IN INDIA.— THE REIGN OF THE SPINNING-WHEEL FOR TWO HUNDRED YEARS IN ENGLAND. — THE INVENTION OF JAMES HARGREAVES, 1765. — RICHARD ARKWRIGHT. — SKETCH OF THE GROWTH OF THE COTTON MANUFACTURE IN THE COLONIES AND THE UNITED STATES. — ELI WHITNEY'S INFLUENCE UPON THE BUSINESS. — OF THE DISTINGUISHED SAMUEL SLATER. — THE MANUFACTURE OF COTTON THREAD. — THE WILLIMANTIC LINEN COMPANY, OF WILLIMANTIC, CONN., THE LEADING THREAD-MAKERS OF THE UNITED STATES. — THE FOREIGN THREAD-MAKERS FINALLY SURPASSED. — THE BEST COTTON THREAD IN THE WORLD MADE HERE. — THE POPULAR SIX-CORD THREAD FOR SEWING-MACHINE USE. — THE PROCESS OF MANUFACTURE OUTLINED. — SKETCH OF THE RISE AND PROGRESS OF THE COMPANY. — ITS VAST FACTORIES. — ITS UNRIVALLED PRODUCTIONS. — OF THE LATE MR. LAWSON C. IVES. — MR. AUSTIN DUNHAM. — SCIENTIFIC MECHANICS IN CHARGE OF THE VARIOUS DEPARTMENTS.

PERHAPS the modern triumph of no art is more marked than that of the making of thread now, over those days when the fibres of the material of which it was to be constructed were carded, and placed upon a distaff held under one arm, were drawn out by the thumb and fingers of the operator's free hand, and twisted into yarn of the size desired; while in these times the manufacture of perfect six-cord cotton thread requires that the fibres of a certain quantity of cotton (say thirty-seven ounces, for example, or enough to constitute a "lap") undergo, from the time they are taken from the bale to completion, sundry operations in which they are "doubled" (as the technical phrase is) or inter-combined over twenty billions of times! It is impossible for the mind to comprehend so vast a number, to count which, at the rate of two hundred a minute, would occupy over a hundred and ninety-six years, day and night, without ceasing. Yet in order to produce a perfect six-cord thread no less "doubling" will suffice. A six-cord thread could be made, and is manufactured, with less than 500,000

"doublings;" and the writer knows of but one mill in the United States which expends a larger amount of labor on its thread than indicated by the latter figures. But the skilful mechanic knows that every doubling which the cotton receives in its progress from the pickers to the final spooling adds to its value; and the conscientious manufacturer will withhold nothing of value to his thread from the consumer.

History is silent as to the birth of the distaff, but it was probably one of the earliest inventions of man, and, as an emblem of woman's domestic slavery, is found pictured upon the very earliest historic monuments. The housewife of to-day, though a slave in many things which still remain to be reformed, owes a debt of gratitude to the genius and enterprise which have emancipated her from the distaff and the spinning-wheel, and which place in her lap for use, at barely a nominal cost, a thread the equal of which in practical value could not have been made by hand by the continuous and united labor of her ancestors in line from a thousand years back.

The progress from the distaff to the mule (German *mühle*, mill) or mule-jenny, with its improvements of to-day, has been slow indeed. The spinning-wheel succeeding the distaff was unknown in England until some time during the reign of that admirer of woman, Henry VIII. (1509–47), when it was imported into that land from India, the country which has supplied so much of wealth to Western Europe, both physical and mental. The spindle, caused to revolve at high speed by the wheel, twisted the material to be spun, in place of the human fingers with the distaff. It is but a generation ago that in New England, and throughout the country, a spinning-wheel was to be found in nearly every house, for the spinning of woollen yarn, and flax, and linen thread, and sometimes cotton thread, although at that time cotton thread was largely manufactured in England and the United States. One reason for the continuance of the household manufacture to that date was the fact that the early machinery of the factories did its work incompletely, leaving the yarn or thread irregular, and it may properly be said that perfectly operating thread machinery has not been achieved till within the last five years.

For over two hundred years after the introduction of the spinning-wheel into England it remained the chief means of manufacturing yarn and thread; but about the year 1765 James Hargreaves, of Lancashire, England, invented the spinning-jenny, in which the

single spindle of the old spinning-wheel was supplemented with seven more, making eight spindles, and the framework turns over on its side. The yarn, as it was twisted on the several spindles, passed through a wooden clasp, held in one hand by the operator. Eventually seventy-two more spindles were added to these, and the jenny became a very important mechanical force, and the now formidable Hargreaves was driven from his home by his competing brethren, who, at Nottingham, erected a small factory to spin yarns in by his machines, and was conducting business there, when, in 1768, Richard Arkwright, of Preston, Lancashire, conceived the notion of spinning by rollers, by drawing out the "slivers," or rolls, as they came from the cards, and by a slight tension elongating and strengthening the fibres. Eventually Arkwright found capitalists who looked favorably upon his conception, and a skilled mechanic, in a Mr. Strutt, of Nottingham, to perfect his crude mechanical devices, and finally a machine driven by the power of a horse was achieved, and in 1771 (just a hundred years ago) a mill driven by water power was established at Cromford, Derbyshire. From that time on spinning machinery slowly grew in favor, and in ten years from that time Arkwright was giving employment to some five thousand people in his mills, and had laid the foundation of his afterwards vast fortune.

But in 1779 Samuel Crompton, of Bolton, England, invented a machine which combined the advantages of Hargreaves' jenny and Arkwright's rollers, and was called the "mule-jenny" (mill-engine) or mule. The spindles were attached to a carriage which was run back and forth a short distance on wheels, drawing out and stretching the "roving" (roll or "sliver" of wool, cotton, etc.), while at the same time it was spun or twisted into yarn or thread. Crompton's machines, though as originally constructed carrying but twenty or thirty spindles, were eventually enlarged, and made with twenty-two hundred spindles each, kept in operation by one person — a vast triumph over the old spinning-wheel. At the present time some thirty millions of spindles are running in Great Britain, ten millions in the United States, and seven millions in France, for spinning cotton alone.

The invention in 1793, by Eli Whitney, of the cotton-gin, by which the seed of the cotton is easily separated from the fibre, stimulated the growth of cotton to feed the new spinning-machines. (Before that time the separating of the seed from a pound of the fibre was a day's work for a field hand; and it may be re-

marked here that, probably, Whitney's genius in mechanics resulted in as much evil, by incidentally prolonging the chattel slavery of the black race in this country, as it did good in supplying the world with a cheap fabric for clothing.)

About 1786 two Scotchmen — Alexander and Robert Barr — constructed, at East Bridgewater, Mass., the first machines for carding, roving, and spinning ever made in the United States. The state, by a grant of two hundred pounds in 1789, encouraged the enterprise. In Beverly, Mass., a company for the manufacture of cotton goods commenced operations in 1787, spending some four thousand pounds, and finally receiving a grant from the state of one thousand pounds, by the aid of which they succeeded in establishing themselves. But their machinery was very imperfect. At Providence, R. I., another company was formed in 1788, and went into operation with poor machinery, mostly fashioned after that of the Barrs, and that in use by the Beverly company. At this time it was impossible in this country to obtain plans of the Arkwright machinery, the English government forbidding such plans to pass through the custom-house, and jealously guarding the interests of its own manufacturers.

But in 1789 Samuel Slater, a young man of only twenty-one years of age, but having had seven years' experience in the cotton mills of Derbyshire, arrived in New York with the intention of establishing the manufacture in this country by the processes of Arkwright, of which he thoroughly informed himself, and plans of which a retentive memory of mechanical matters enabled him to bring hither in a manner inscrutable to the custom-house officials. Early in 1790 he went to Providence, R. I., and entered into an arrangement with manufacturers there to construct for them the Arkwright machinery. In a year from that time it was demonstrated that a year more would suffice for the erection of mills and machinery enough to supply the entire country with yarn. With others, Slater erected a small mill at Pawtucket, in 1793, in which seventy spindles were at first operated. The capacity of the mill was soon after much increased. From this beginning other mills were erected in various places in Rhode Island, and eventually in Massachusetts — in 1813 there being built at Waltham, Mass., a mill which is believed to have been the first one in the world which combined all the requisites for making finished cloth from the raw cotton. In 1822 the first cotton mill in Lowell, Mass., was erected.

But we have not space in this article to narrate the progress of cotton manufacture in this country, step by step, to the present time. Of the gigantic proportions of the cotton interest, embracing the cultivation of the cotton plant and the spinning of the fibres of its flowers into threads, and weaving them into cloth, vari-colored by the dyer's art, and now made by him more beautiful in hue than was ever silk touched by the magic hand of the Tyrians, the general reader is fully aware.

The manufacture of cotton thread is now very extensive in the United States, and in the art of making it, is better understood today in this country than in Europe, and a good portion of the thread made here is preferable, especially for use in sewing-machines, to the best imported. Yet till within a year or two sundry manufacturers in the United States, deferring to the popular prejudice in favor of the best imported thread, caused their own thread to be stamped like the foreign thread, and put up in thoroughly soldered leaden boxes, as do the foreign manufacturers for export — (in order to protect it against moisture in its imaginary transit over the Atlantic Ocean!) — and this practice is still pursued by one extensive manufactory of thread. But more perfect processes of manufacture having been discovered, have enabled the leading cotton-thread manufacturers of the United States, the Willimantic Linen Company, of Willimantic, Conn., within the last five years, not only to modify, but to almost abolish, the prejudice in favor of the foreign cotton thread by the production of a greatly superior article. These processes being under the exclusive control of this company, have secured for its thread a perfection which can be justly claimed for no other thread made in any part of the world, placing the company quite beyond the sphere of competition with both foreign and domestic manufacturers. This fact may properly be styled one of the greatest triumphs which American inventive genius, skill, and labor in any line of art have achieved over the productions of foreign talent and enterprise, and it gives the Willimantic Linen Company not only the preëminent place among cotton thread makers, but a position in the front rank of American manufacturers.

The making of cotton thread through the various processes, from the pickers on till the yarn is reached, consists in little more than the due selection of the filaments, and their proper combination in a vastly attenuated form; but the processes are delicate, requiring the greatest scientific precision in machinery, and in the

MANUFACTORY OF THE WILLIMANTIC LINEN CO., [illegible]

Willimantic Linen Company's establishment, so much more numerous and extended are these than in any other, that, whereas the yarn is reached in other mills after the filaments have undergone "doubling" or re-combinations less than four hundred thousand times, in the Willimantic Linen Company's works the yarn is not considered complete until its filaments have passed through over seven billions of "doublings" (its six-cord thread being completed only after over twenty billions of "doublings," as referred to in the first paragraph of this article). But all this labor is necessary to the production of the perfect six-cord thread, flexibility, strength, and perfect smoothness being the chief requisites of a good thread.

The mode of making thread may be but little more than intimated, rather than described to the general reader, without diagrams of the intricate machinery used. The cotton, as taken from the bale, somewhat combined with dirt, and not fully free from seeds, is, in the quantity of about thirty-seven ounces at a time, placed in a "picker," so-called, to render it free of seeds and foreign substances. In this machine are sundry "beaters" or cylinders, provided with iron teeth, and running at the rate of twenty-two hundred revolutions a minute, through which the cotton is passed, coming ont a clean "lap" of about an inch in thickness and a yard wide. Three of these laps are together passed through another picker, and, combined, are taken to the "breaker cards," whence the whole comes forth in the shape of a long soft rope of an inch in diameter, and called a "sliver drawing," which is taken to a "lap winder," and is made into a lap again. This is taken to another section of cards, called "finishers," where it is further advanced towards perfection into a sliver drawing again. Several of these machines are in line, and their products are run together into "railways," which compress the several "drawings" into one "sliver," which is deposited in a cylindrical "can," the contents of which are taken to a "lap-winder" in which a number of "slivers" are made into what is called a "comber lap." This machine is a very ingenious device. This "comber lap" is then taken to another "lap machine," and, united with other laps, is made into a lap of finer character, which latter is taken to a "combing machine," a beautiful piece of deft mechanism of French invention, where a certain per cent. of the shorter fibres are eliminated from the "lap." The longer fibres being freed from the shorter, the better portion is taken to a

"drawing frame," where it passes through three processes, out of which it comes as a very smooth and even "sliver," which is passed on to a machine called a "slubber," where it is turned into "roving" (a slightly twisted roll), and is run upon bobbins, when it is ready for the "first intermediate fly frames," so-called, on which it is drawn down more fine; then taken to the "second intermediate" fly-frames, where it undergoes further attenuation, and is then placed in a "jack frame," where a fine "roving" is made of it for spinning, it being then called "No. 26, hank roving."

The number of times in which the filaments of cotton up to this point have been "doubled" (or combined, adjusted and re-adjusted as to each other), in their sinuous passage through the multifold parts of the various machines to which they have been subjected, is 1,725,235,200! — all necessary for the purpose of rendering the thread which is to be made from it more "level and uniform," as the technical phrase is. The carding-room of the Willimantic Linen Company, wherein the various processes we have described are conducted, is under the charge of Mr. Andrew Hammond, a man of that order to whom the nation and civilization at large owe more than to any other body — the accomplished and ingenious mechanics.

Much depends upon the state of the atmosphere in the making of cotton thread: sometimes it is too dry. It has been always claimed by the English manufacturers that good thread could not be made in this country on account of the dryness of our climate; but Yankee genius has devised a plan, which is in operation in the Willimantic Linen Company's mills, by which a moisture is imparted to the air which is preferable to the natural humidity of the English atmosphere, because it is under perfect control.

From the carding-room the "roving" upon bobbins is passed on to the "mule-room," so called, where the roving of two bobbins is spun into one upon a "cop," or sort of bobbin. It is now prepared for weaving, or to pass through the final processes into thread. In the establishment in question it is all made into thread. From the spinning-room the yarn on the "cop" is taken to the "twisting-room," where it is first "steamed" to render it more flexible, and prevent it from "kinking" in the process of spooling; then placed upon a spooling-frame, and the contents of two "cops" run together upon a spool. The spooling-frame, like

most of the machinery in this establishment, is automatic in its action, and if one of the threads chances to break, the spool ceases to revolve. It is then taken to the "first twisting" machines, and run on to bobbins and twisted; thence to another set of "twisters."

After passing the twisting process, the thread is taken to the "doublers" (machines of peculiar construction, made by the Willimantic Linen Company themselves), where three (already doubled) threads are run together, and then transferred to a final twisting machine, and made into six-cord thread, having now undergone 20,702,822,400 "doublings," and is subjected to further spooling, running upon reels, into skeins of one thousand yards in length, which are now inspected, and the perfect ones passed on to the dyeing or bleaching department. Leaving thence, it is run on to large spools, and taken to the "finishing-room," where the soft finish is applied. The next process is the winding of the thread upon small spools for the market, it being wound upon ingenious automatic machines, the letters patent of which are held and controlled by this company. These machines are so gauged that they necessarily run upon each spool two hundred yards of thread, and stop winding off only when that length is reached, thus assuring purchasers of full measure. The capacity of the machines in this room is fifty thousand dozen spools a week. These are then inspected, and the perfect are passed to the "ticketing machines" (wonderful devices, the patent of which is exclusively controlled by the Willimantic Linen Company), and then stamped or "ticketed" on both ends at the same time, each machine ticketing eighty spools per minute, and the total number of machines being able to ticket twenty-four thousand dozen spools a day. A red ticket is placed upon one end of each spool of six-cord thread, to distinguish it from the three-cord manufactured by this company, and forms a trade-mark for their popular soft-finish thread. After the ticketing and placing in paper boxes, the packing follows, and the thread is then ready for market.

Our female readers, especially, will be interested to know how much of careful labor, patience, etc., is necessary to produce that magical thing called a six-cord cotton thread, and we have endeavored to give them some conception of it. In a certain sense thread unites the world, since it is used in nearly every semi-civilized, as well as civilized, family over the globe; and the six-cord thread of the Willimantic Linen Company, which, by reason of

its great superiority to any other thread, worthily enjoys the patronage of the leading manufacturers of sewing-machines, finds its way wherever the wonderful invention of Howe, and the machines of the Wheeler & Wilson and the Weed Sewing Machine companies, and other great manufacturers, are to be found. On account of its superior strength and smoothness this thread never breaks in a sewing-machine, and always "runs easy." A good share of the thread of the Willimantic Linen Company is used by straw goods, knit goods, clothing and hat manufacturers; but the greater portion of their thread being specially adapted for the use of sempstresses, is consumed in the family circle, by hand, and on machines.

The Willimantic Linen Company (whose name is now a misnomer, the company being organized at first to manufacture linen goods only) was established in 1854, principally by the late Lawson C. Ives and its present treasurer, Mr. Austin Dunham, both of Hartford, Conn., uniting the great energy, perseverance, and general business talent of the former to the equally marked excellent judgment and great financial ability of the latter, who may be said to be without a superior, if not a peer, among New England manufacturers, in his special department. Mr. Ives died in 1867, having amassed a large fortune, and crowned in his lifetime (an example to other men of wealth) his career by sundry valuable charities, among which was the erection at Hartford of a home for indigent widows. The company started with a capital of only $75,000, which was soon increased to $125,000, and in 1856 to $225,000. Its present capital is $1,000,000.

The factories of this company are noble structures of granite, in which sixty thousand spindles are kept running. Their factory, in which three-cord thread is manufactured, is four stories in height, two hundred feet long by sixty-eight in width, while that appropriated to the manufacture of six-cord thread (and called the "new mill") is five stories in height, four hundred feet long, seventy feet wide, and remarkably well constructed throughout, and furnished with the very best machinery. It is indeed a "monument of architectural beauty." Every provision is herein made for the comfort and security of the operatives. The building is supplied with four of Fales, Jenks & Sons' force pumps for security against fire, each capable of discharging thirteen hundred gallons of water in a minute. The water power of these mills is "800-horse," to which a Corliss steam engine of three hundred horse power is about

to be added. Besides the substantial buildings spoken of above, the company have a dye-house and bleachery immediately attached to the new mill, and which is one hundred and twenty feet in length by seventy in width, with drying rooms of about the same capacity.

This department, under the charge of Mr. James M. Reid, a gentleman of scientific attainments, and probably unequalled anywhere in his profession, is very complete in its arrangements, and is, perhaps, the finest establishment of its kind in the country. The mode of ventilation in the lower rooms, where immense quantities of steam are generated, is new, unique, and very efficient, and the labor-saving appliances and general fitting up of the department are such as to greatly reduce the amount of manual labor usually needed in such operations, and also to promote the comfort of the workmen. Four thousand pounds of thread a day can be turned out when the place is run to its full capacity. Attached to the main building is the boiler house, which contains eight steam boilers, in which steam is generated for use in the dye house and the mill generally. In the upper story and attic of the main building are the store rooms for receiving and storing the product of the several mills, and from these store rooms are drawn the required numbers and quantities to fill immediate orders. All colors and every imaginable shade of color can be produced here to suit customers.

Turning, carpenters', and machine shops, rooms for the manufacture of paper boxes, etc., complete the body and appointments of this company's vast establishment, which is under the immediate care of Mr. A. B. Burleson, the resident agent, of whom, in his business capacity, perhaps the most complimentary thing which could be said is, that he admirably directs the manufacturing business of the leading thread making establishment in the United States.

CLOCKS.

THE SUN-DIAL. — THE "MIRACLE" OF AHAZ. — THE TIME-PIECE AND THE CLOCK. — OLD AND CURIOUS CLOCKS. — THE CLOCK TOWER OF ST. MARK'S, VENICE. — THE OLD CLOCK TOWER OF BERNE, SWITZERLAND. — THE CLOCK A COMBINATION OF INVENTIONS. — THE PENDULUM CLOCK. — CONNECTICUT CLOCK MAKERS. — ELI TERRY AND RILEY WHITING, PIONEER CLOCK MAKERS. — THE NUMBER OF CLOCKS MADE IN CONNECTICUT ANNUALLY.

THE motions of the heavenly bodies doubtless suggested the practice of measuring time — of dividing it into years, days, and hours. From the earliest period, the space which elapsed between sunrise and sunset has been called a day, and that from sunset to sunrise a night. At a later period the day and night were divided into twenty-four equal parts, called hours, an hour into sixty equal parts, called minutes, and a minute into sixty equal parts, called seconds.

The sun-dial was one of the earliest inventions used for measuring time. It is supposed to have originated with the Babylonians. Greek historians affirm that the Greeks received from them the dial, the gnomon, and the division of the day into twelve parts. The first mention in the Scriptures of the hour is made by the prophet Daniel. (iii. 6.) Though the dial was used early by the Egyptians, yet there are no indications in their sculptures to show the epoch when it was first known in Egypt. The earliest clear reference to the dial is in the second book of *Kings*, xx. 11: "The prophet cried unto the Lord, and he brought the shadow ten degrees backward, by which it had gone down in the dial of Ahaz." This miracle is said to have occurred in the reign of Hezekiah, the son of Ahaz, and his successor. It was called the dial of Ahaz; he had been in alliance with the king of Assyria, and had communication with the princes of Babylon. He was a man of progressive ideas, and ready to adopt foreign improvements. The dial,

in the mode of its construction, was undoubtedly imported from Babylon. It was probably only an object of curious recreation for the king, or served at most to regulate the occupations of the royal household. There is no mention in the Scriptures of any instrument for keeping time before this dial of Ahaz, seven hundred years before the Christian era.

The pieces of mechanism used to measure time, and kept in motion by gravity through the medium of weights, or by the elastic force of a spring, are called time pieces, or clocks. The term time piece is applied to an instrument intended merely to mark the time without striking the hour; a clock, besides showing the time, strikes every hour on a bell or a spring.

The first author who speaks of a clock appears to be Dante, who wrote in the latter part of the thirteenth century. He says, as rendered by Cary, "as wheels, that wind their circles in the horologe," implying his knowledge of a clock of some kind. Striking clocks are said to have been invented at Padua, Italy, and that which now exists in the tower in the Piazza de' Signori, is claimed as the contrivance of Giocomo Dondi. It was erected in the year 1344. Besides the four and twenty hours, it tells the course of the sun and the aspects and phases of the moon. Dondi obtained such celebrity for his performance that he acquired the surname of Horologio. It passed to his descendants, and the family of "Dondi dell' Orologio" still flourishes. The exact period when clocks were first known in England is uncertain. Early in the fourteenth century a wonderful clock was produced by the abbot of St. Albans, which is referred to as the oldest one known in England. A German artist named Henri de Vic, or Henry de Wick, put up a large clock in the palace of Charles V. of France. Very old and curious clocks are found in different cities of Europe, which have been noticed by travellers and writers for centuries. Strasburg has a famous clock made in the year 1571. At the hour of twelve the clockwork puts in motion many puppets and images. There is a clock tower in the square of St. Mark, Venice; in the centre of it is the dial of a very old clock, which is resplendent with gold and azure, the sun travelling round the zodiacal signs which decorate it, and marking the time of twice twelve hours. On the top of the tower are two large figures of bronze, called by the Venetians, Moors, who, with large hammers, beat the hours upon the bell. They strike the hours twice, the second set of strokes being at an interval of five minutes from the first. A

story of the last century, current in Venice, charges one of these bronze men with murder, by knocking off the parapet an unfortunate workman who stood within the swing of the hammer. The city of Berne, in Switzerland, has an old clock tower, built nearly eight hundred years since. Its comic clockwork puppets are objects of wonder to an admiring crowd of observers. A minute before the hour strikes, a wooden cock appears, crows twice, and flaps his wings; then, while a puppet strikes the hour on a bell, a procession of bears comes out and passes in front of a figure on a throne, who marks the hour by gaping and by lowering his sceptre. In the year 1382 the town of Courtray, in Belgium, was burned by order of the king of France. Before the town was set on fire, Froissart says, "The Duke of Burgundy had taken down a curious clock which struck the hours, the handsomest that was to be seen on either side of the sea, which he had caused to be packed up and placed on carts, with its bell, and carried to Dijon, where it was placed, and there strikes the hours day and night."

The middle of the fourteenth century may be regarded as about the time which affords the first clear evidence of the existence of what would be now called a clock, or regulated horological machine. It is not an invention so ancient as some have supposed, nor is it altogether the invention of the two last centuries. If, as a complete machine, it had an inventor, he is not certainly known. Ferdinand Berthoud, who has written voluminously on the subject of clockwork, concludes his researches with the opinion that a clock, such as that put up by Henry de Wick, is not the invention of one man, but a combination of successive inventions, each worthy of a separate contriver. "Thus (1), wheelwork was known and applied in the time of Archimedes; (2) a weight being applied as a maintaining power would in all probability have at first a fly, similar to that of a kitchen-jack, to regulate the velocity; (3) the ratchet-wheel and click for winding up the weight, without detaching the teeth of the great or main wheel from those of the pinion in which they were engaged, would soon be found an indispensable contrivance; (4) the regulation by a fly being subject to great changes from variations in the atmosphere, and the tendency of a falling body to accelerate its motion, would necessarily give rise to the alternating motion of the balance, with which invention an escapement of some kind must have been coupled; (5) the last-mentioned two inventions are most important ones, and would have induced such a degree of equability in the motion of

the wheelwork as would lead the way to a dial-plate, and its necessary adjunct, a hand or pointer; lastly, the striking part, to proclaim at a distance, without the aid of a person to watch, the hour that was indicated, completed the list of inventions." It is supposed that the clock of Henry de Wick was constructed by combining the successive inventions of different persons. And so the clocks of the modern times have been brought to their present degree of perfection by a series of inventions and improvements on what may now be called the rude clocks of the fourteenth and fifteenth centuries.

About the middle of the sixteenth century clocks were reduced in form so as to be easily transported from place to place. Before portable clocks were made, a main-spring, as the moving power, was probably substituted for weights. About a century later the long-pendulum clock was made. The honor of originating the pendulum clock is claimed for different individuals.

In the year 1639 Galileo Galilei published his observation on the pendulum in Paris: though it is said he never applied the pendulum as a regulator to supersede the balance in clocks, yet his discovery doubtless led to its use. In the year 1641 Richard Harris, a London artist, applied the principle discovered by the French philosopher, and is supposed to have made the first pendulum clock. The English have continued to make improvements in clocks, and are able to produce the very best specimens of work. The French also continue to the present time to make great numbers of clocks; they are not expensive, but serviceable, and externally neatly finished, and sometimes highly ornamented. The English generally make their clocks by hand; the movements of French clocks are made by machinery.

It is due to the skill and enterprise of Connecticut clock-makers that good, serviceable clocks are made at such a low price that every family can afford to be the owner of a timepiece. Nearly all the clocks used in this country have been made in the State of Connecticut, and the manufacturers export them in large numbers to almost all foreign countries. Towards the close of the last century, Eli Terry established himself in the town of Plymouth, Litchfield County, Conn., and commenced making the old-fashioned hang-up wooden clocks. At this time the wheels and teeth were cut by hand, — first marked out with square and compass, and then sawed with a fine saw. The movements of these clocks were sold for about twenty-five dollars each. In the year 1807 Mr.

Terry commenced making wooden clocks by machinery. About the same time Mr. Riley Whiting, a gentleman of scientific education, and of great business capacity, established the manufacture of clocks at Winchester (now Winsted), Conn., and conducted the business there till 1835, when he died. Mr. Whiting made numerous improvements in clocks and clock cases, and became the most important clock manufacturer of his time, in this country. In less than five years the competition in clock-making was so great that the price of the movements for a single clock was reduced to five dollars. The greatest revolution in clock-making in Connecticut was the introduction of the one-day brass clock, an invention of Mr. Chauncey Jerome. The parts of this clock are made by machinery, so that cases can be sold at fifty cents each; and the brass wheels, which are stamped from plates, are made so rapidly that the cost of the movements for each clock is less than fifty cents; so that the one-day brass clocks can be sold for from one and a half to two dollars each. The rapidity with which the clock movements are made is apparent when we consider that three men can take the brass in sheets, press out and level under the drop, then cut the teeth, and make all the wheels for five hundred clocks in one day. The facilities for making cases are such that the labor on the case of an O. G. clock costs less than twenty cents, while a cabinet-maker could not manufacture one for less than five dollars. The dials are cut from sheets of zinc, painted, and lettered at a cost of less than five cents each; the painting of the tablets, the glass, and work cost about five cents each. Thus the million, in all countries, may easily supply themselves with this almost indispensable article of household furniture.

In the year 1842 a consignment of Connecticut brass clocks was sent to England by Mr. C. Jerome. From that time, it is not too much to say that millions of them have been sent to Europe, Asia, South America, Australia, China, and the islands of the sea.

The largest establishments for clock-making are found in New Haven, Waterbury, Plymouth, and Bristol, Conn. In these places half a million of clocks are manufactured annually.

PAPER FURNISHING GOODS.

VARIOUS USES FOR PAPER. — BOATS, FURNITURE, AND FLOWERS. — PAPER FOR THE WARDROBE. — CHINESE PAPER CLOTHING. — JAPANESE PAPER HANDKERCHIEFS. — CLEANLY CIVILIZATION. — PAPER DRESSES AT FANCY BALLS. — DRESS PATTERNS. — NEGRO MINSTREL COLLARS. — RESORTS OF DECAYED DANDIES. — DELAY OF THE INVENTION. — THE INVENTOR. — PREJUDICES AGAINST THE NEW FASHION. — IT FINALLY TRIUMPHS, AND THE BUSINESS BECOMES EXTENSIVE. — THE LEADING MANUFACTURERS OF THE UNITED STATES, MESSRS. RAY AND TAYLOR, OF SPRINGFIELD, MASS. — HOW PAPER COLLARS ARE MADE. — PROCESSES. — THE TURN-OVER AND GARROTE COLLARS. — ANECDOTE OF HENRY WARD BEECHER. — CELEBRATED STYLES OF COLLARS. — VARIOUS PAPER GOODS. — THE ESTABLISHMENT OF MESSRS. RAY AND TAYLOR.

WITH all the multitudinous and different purposes to which paper is now devoted, it is probable that we are still only on the edges of discovery as to the vastly many more uses to which it is applicable. From its first obvious utility as a medium for the communication and preservation of written characters, and afterwards its greater value when printing was discovered, paper became indispensable in almost every art and trade, from that of the engraver, who requires the finest sheets for his pictures, to that of the retail grocer, who enwraps his goods in the coarsest "straw," or brown. As papier-maché, paper pulp mixed with glue or gum, or paper pasted or glued in layers upon moulds, it is used for making almost everything, where wood for the same purpose could be used, and appears in a multitude of forms, from small toilet articles, watch and match holders, and dressing-cases, to furniture, piano-cases, and even boats; and it is found to be an excellent article for making moulds for stereotypes. It is also used in architectural mouldings, for picture-frames, for daguerreotype-cases, for hundreds of things, while sheet paper, plain and colored, is made into various trimmings, artificial flowers, and bits

of white paper even make the "snow-storms" of the stage in theatres.

But the use of paper in the wardrobe of "Young America" is of recent introduction. For centuries the Chinese have gayly clothed their idols in colored and gilt paper. The Japanese, from time immemorial, have used paper pocket-handkerchiefs, carrying several in their pockets, using one and throwing it away, and from that custom claiming a cleaner, if not higher, civilization over the "barbarians" who carry a single silk or linen handkerchief, which they use repeatedly, and as often return to their pockets. Paper over-dresses, with lace paper collars and trimmings, are occasionally seen in masquerade and fancy balls. When negro minstrelsy first became an institution in the United States, the "end men" used to wear enormous collars cut from card-board or drawing-paper; and years ago there was a common slander, sometimes well founded, that decayed and impecunious dandies wore paper bosoms, collars, and cuffs to conceal the absence of an important article of dress which might be at the wash, or to cover the dirt in the same article which should be at the laundry.

It is singular, considering how close some one must have been to the discovery, that the invention of the now almost universal paper collars and cuffs should have been so long delayed. But in 1853 paper collars for men's wear first appeared in New York, and the new goods soon spread to other cities. At first they were laughed at and ridiculed, as exhibiting a sure sign of poverty in the wearer. Then came a horrible story that the paper possessed poisonous properties, dangerous to those who indulged in the new and cheap luxury of a clean collar every day for less than the cost of washing, and collars that might be turned and worn again before they were thrown away. Washerwomen rebelled against an invention which threatened to materially lessen the conventional dozen, more or less, of every customer per week. Society pronounced the new fashion low and vulgar. The makers of starch calculated the probable reduction in their sales. In fact, the paper collar created a commotion which largely helped to advertise it, and assisted in its introduction to popular use. All prejudices, even those against the most startling innovations upon established styles of dress, are easily worn away; and when it was discovered that the chief value of the paper collar lay, not in its cheapness, but in its convenience, the new fashion speedily became a success.

Walter Hunt, of New York, claimed the invention of pasting or cementing two pieces of paper together to give the required stiffness and surface for collars, which were cut into shape, and then rolled with a serrated wheel to give the imitation stitches on the border. The inventor and a few of his friends were hardy enough to exhibit such collars on their own necks in public. But the soft and unsubstantial character of the material soon suggested the placing of a strip of thin muslin between the pieces of paper; and with this invention, duly patented, the paper collar of to-day was discovered. At first the business was dull and unprofitable; but it has finally become one of the great industries of the land, covering not only collars, but cuffs, bosoms, etc., and is conducted in several different places, the leading house being that of Messrs. Ray & Taylor, of Springfield, Mass., whose business may be said to ramify throughout the United States, hardly a hamlet to be found in which these superior wares are not to some extent worn.

The process of manufacturing collars, cuffs, bosoms, etc., is considerably detailed, and may be all sufficiently well described under that of collars. In the establishment of Messrs. Ray & Taylor, the prepared paper or stock, as brought directly from the manufactory, is first taken to the stock room and inspected. It should be remarked, however, that the firm prepare for themselves that portion of their stock which requires the nicest manipulation. After inspection, when a case of paper is wanted, it is placed upon a car, and the car is rolled to and upon the elevator, which then ascends to the machine room, and the car is rolled to the press, where, by means of suitable dies placed under the ponderous machine, the first process of manufacturing commences by cutting out from thirty to eighty articles at a time. If the articles are "Byron," or turn-down paper collars, they are then rolled in cases upon a car to the enamelling room, where, by an ingenious machine invented by the proprietors, they receive a coat of enamel as far down as the "turn-down" line, leaving the inside of the collar, which comes in contact with the neck, plain, and free from enamel. This enamel which they use is water-proof, and will not rub off by being wet or moistened by perspiration. When the enamel is dry, the articles are passed through another ingenious and powerful machine, which imparts to the enamel surface an exact imitation of linen, so that one would suppose, even upon a close inspection, that they were really of cloth or linen, and prepared for use by a careful and experienced laundress. This

process is also an invention of their own, for which they hold valuable patents. In the manufacture of "garrote," or "stand-up" collars, the paper receives its "linen finish" in several sheets at a time.

These garrote collars are known, according to their several peculiarities, as the "Derby," after the celebrated Lord Derby, who devised the pattern; the "Ray," after one of the firm; and the "Beecher garrote," after the illustrious preacher, Henry Ward Beecher, with his consent; and, *passim*, as illustrative of the tact of Yankee business genius, and the democratic good sense of some of our clergy who are outgrowing the weak notion that they are demigods, or better than other people, it will not be out of place to quote here Mr. Beecher's reply, when applied to for the use of his name for the collars. He was assured that the house would do no discredit to his good taste and name by their wares. Mr. Beecher's letter is as follows: —

"BROOKLYN, March 3, 1869.

"MESSRS. RAY & TAYLOR.

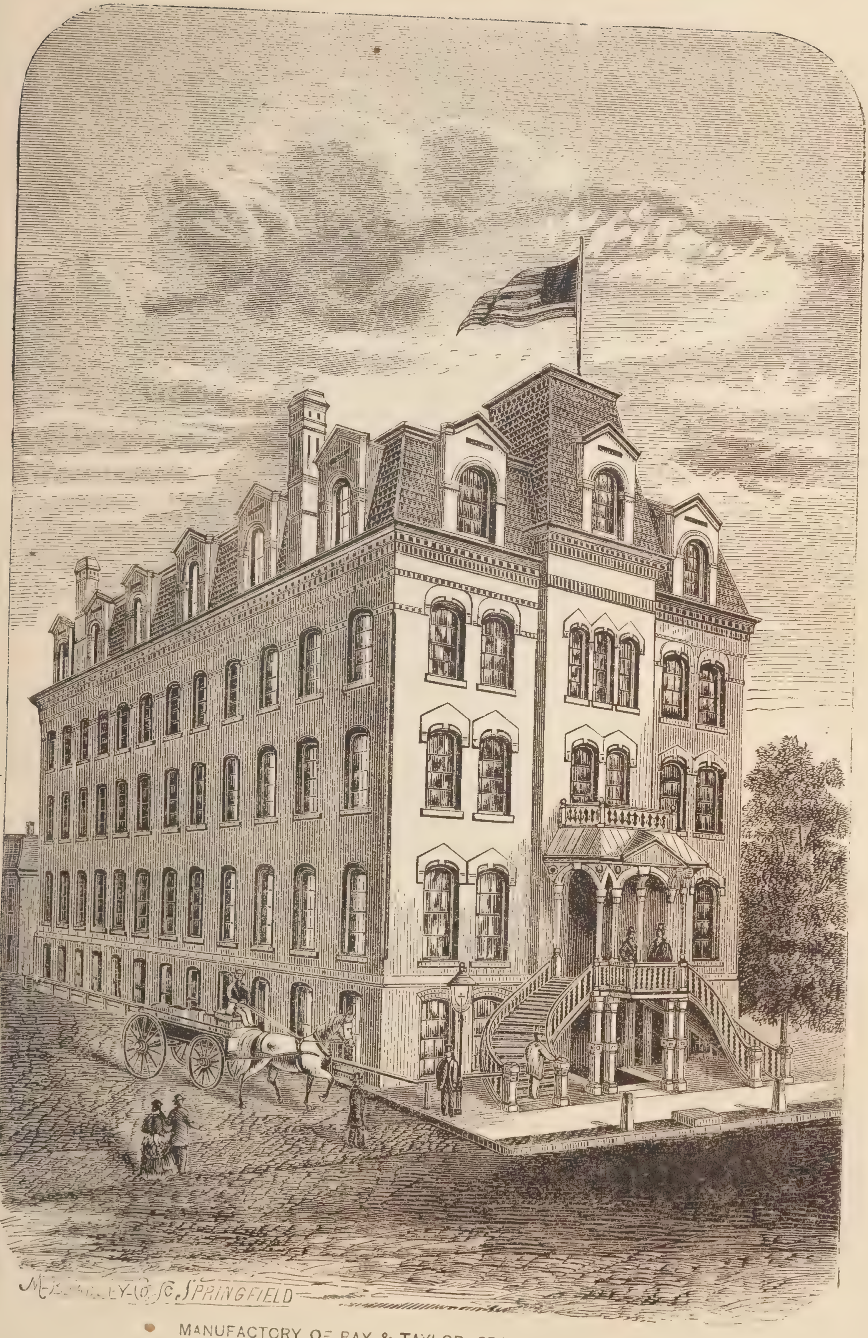
"GENTLEMEN: My name has been used so much for all sorts of things that I doubt whether I could substantiate, in a court of justice, any claim to it; and, of course, it would not be fair to forbid you the use of it.

"I hope your enterprise may be successful, and that the collars may be good enough for the name, and the name never disgrace the collars. Respectfully yours,

"HENRY WARD BEECHER."

These garrotes, like the rest of Messrs. Ray & Taylor's collars, are of the best possible workmanship, and as a consequence very popular.

After the linen finish is given them, the collars are taken to the next machines, the embossers, all of which are of this firm's invention, and are a great improvement over the old "finger-cutters" generally used. Here they receive the "stitching," size and "patent mark," all at one impression, being put into the machine one by one by dexterous female operators. Next come the "punching machines," where from four to eight collars or cuffs receive their button-holes at a time. They are then passed on to the "folders," where, upon each machine, about thirty thousand collars per day are folded, or rather creased, for the folding process is not completed until they have passed through the next machine,



MANUFACTORY OF PAY & TAYLOR, SPRINGFIELD, MASS.

the "roller," which squeezes down the crease, and completes the collar. Next come the "putting-up tables," at each of which five or six young ladies count out the collars as fast as rolled into bunches of ten each, and, by a dexterous twirl or twist, put each bunch into its box. Passing on, we come to the "labellers," who arrange the filled boxes in triple rows in concave troughs or racks; and, with wonderful despatch, the whole are labelled, and ten of these small boxes are packed in a larger box, or "carton," each carton thus containing one hundred collars. These cartons are also labelled, placed upon a car, and rolled on to the elevator, and sent to the next floor, or shipping room. Here they are packed, marked, and shipped to all parts of the country.

In passing through this establishment, one is most favorably impressed with the admirable arrangement of machinery and appliances, and with the perfect system and regularity with which each department of the manufactory is conducted. Everything is so arranged that all unnecessary labor is obviated, as the stock or raw material, after being taken from the wareroom, makes its way through the several departments of the establishment in the different processes of manufacture, until it arrives at the packing room, as manufactured goods ready for shipment. Messrs. Ray & Taylor have invented a large portion of their machinery and processes themselves, for all of which they hold letters patent of the United States; and they have in operation certain greatly improved machines for the various departments of their manufacture, the principles of the construction of which they wisely hold as their own secret, and by which they are enabled to do and afford better work at cheaper prices than other manufacturers.

Besides the wearing apparel department, they have also a large paper box manufacturing department, where are made all the boxes used for putting up their wares; so that there is probably no establishment in the country so complete, and that has the facilities which they possess for the successful prosecution of this order of manufacture. In addition to the vast amount of plain "linen finished" and cloth-face collars for gentlemen manufactured by this firm, they do a very extensive business in ladies' collars, cuffs, etc. They are the exclusive manufacturers of the celebrated Curtis bosoms, holding the letters patent thereof. These bosoms can be readily cleaned, so smooth and hard, though flexible, is their surface, with a wet sponge, and may be worn for a long time without deterioration. Ladies' collars and cuffs are made on order

at this establishment in such close imitation of wrought cambric and lace as to deceive the eye without closest inspection, reflecting great credit upon the extreme and delicate skill employed here. Among the collars for gentlemen, which are chiefly sought in the market, this firm are the originators of the "Byron," the "Dantè," "Longfellow," "Derby," "Semper idem," "Semper verum," "Gilmore," and "Persigny" (the "Persigny" was the first name ever given in the United States to a paper turn-over collar), and the ladies' "Shakespeare" and "Florence." This firm avoids the "catchpenny" names of the hour for its wares, which, to the disgrace of some manufacturers, have become far too common.

The establishment of Messrs. Ray & Taylor is an elegant brick edifice, five stories in height, erected by the firm after its own special designs, and adapted throughout for the business, and is most substantially built. Within it is not only elegant, but spacious, as to its several departments, and provided with sumptuous offices, which are furnished with great taste, ornamented with fresco, and appointed with all modern conveniences. Messrs. Ray & Taylor are evidently of that order of successful business men who have an eye to the æsthetics of life. We have frequently remarked, in our inspection of business establishments throughout the country, that the highest class of successful business men are turning their attention more and more to neatness, convenience, and elegance in their establishments; and, as a consideration of business tact, this fact is worthy of comment, inasmuch as these things add to the comfort of operatives. This factory is supplied with that great desideratum and necessity in every large establishment, an elevator, constructed by Messrs. Otis, Brothers & Co., of New York, who are the only manufacturers of elevators in the United States, who have, it would seem, mastered every detail of their art; and the machinery of the factory is driven by a steam engine, built by Mr. George H. Corliss, of Providence, R. I., who has reflected so much honor upon the country by his inventive genius and perfect work.

Messrs. Ray & Taylor's establishment is not only an ornament to the city of Springfield, but a great credit to the spirit of American manufacturing enterprise in general.

FIRE INSURANCE.

THE IDEA OF INSURANCE A MODERN ONE. — THE NATURAL GROWTH OF THE SYSTEM. — FIRE INSURANCE IN THE UNITED STATES. — THE RISK OF FIRE INSURANCE. — THE NEED OF LARGE COMPANIES. — THE INCREASE OF THE BUSINESS. — THE CAPITAL INVESTED IN IT. — AGENCIES. — THE ABUSES OF THE BUSINESS. — SPECULATING COMPANIES. — INAUGURATION OF STATE INSURANCE DEPARTMENTS. — THE LOSS DOUBLED BY A COMPANY'S FAILING. — THE LESSON OF THE CHICAGO FIRE. — THE LOSS IT CAUSED. — MR. LOWE'S SUGGESTION IN PARLIAMENT. — THE ADVANTAGES IT PROPOSES.

THE system of insurance is entirely a product of the modern spirit of society, which tends, in all our social and industrial relations, to replace the isolation of selfishness by the unity of mutual sympathy and aid, or, according to the philosophic formula, egoism by ultraism. The first application of the principle of insurance was to marine risks; and this, as is easily seen, was very natural. The risk of a ship was more unusual than that of a house; the owners of such property were fewer; and the risk of loss being so much greater, it was more natural that those interested should combine. At first the assumption of marine risks was taken by private persons, who agreed to assume the responsibility for a certain amount of loss, and signed their names, with the amount they would insure, under the list of the ship's cargo, and from this practice the name "underwriter," applied to marine insurance, came into vogue. From this arrangement the joint-stock company engaged in insurance naturally arose, and the extension of the principle soon included fire insurance.

In the United States the early attention paid by the colonists to ship-building and commerce caused the practice of underwriting for marine risks to be very soon adopted; and from this beginning attention was finally turned to fire insurance. The precise date when the first company for transacting a fire insurance business was formed does not appear, but before the revolution the business was regularly established. It was the custom in those days,

and even down to within about forty years, to place upon a house which was insured a plate bearing the name of the company which had granted the policy. In many of the villages throughout the earlier settled portions of the country, upon the old houses which yet remain, may still be seen such plates, bearing, in some instances, the date of the year when they were affixed, and some design, such as two hands clasped, or a Phœnix rising from the flames, by which the advantages of fire insurance was typified.

Fire insurance differs from life insurance in being more entirely founded upon chance. It is certain that every one of us must eventually die, but it is by no means sure that every house will burn down. From the average mortality of a sufficient number of persons, the probabilities of life insurance have been calculated with great accuracy ; so that the business can be followed with a method, and a certain rule applied for the decision of any special case. With fire insurance, however, the law of probability has not yet been calculated with such accuracy, and from the very conditions of the question it is probable that it never can be. With the exercise of a proper business precaution, the operations of life insurance can be made as certain as a mathematical problem ; but even the most cautious foresight and care cannot give this definite certainty to the operations of fire insurance. In consequence, therefore, there is always an element of speculation in such transactions, and for this reason the business, in the hands of small companies, can never be made secure ; they have not a large enough range of good risks to cover the loss of any unfortunate one. This has been so frequently proved practically that it is beyond question.

With the great increase in the industrial activity of this country during the present century the business of fire insurance has kept pace, and the capital now invested in companies doing an exclusive business in fire insurance may be fairly estimated at between two and three hundred millions of dollars. So clearly has the truth of the principle, that large companies, doing a wide and extended business, are the safest, been seen by the public, that, throughout the most recently settled portions of the country there has been but little opportunity offered for the establishment of local companies, since they could not offer as good inducements to the public as those presented by the agents of older, richer, and better established companies. In this way the fire insurance business has become a most important interest in certain localities. This

growth of the business of fire insurance, as well as that of other kinds of insurance, brought with it at first natural abuses, such as a greater extension of the business than was safe, and also opened a field to the exploitation of speculative companies, which were not based upon sound financial principles, but hoped by success to make money for their stockholders. Should they do a large enough business, and collect sufficient premiums without meeting any losses, it was evident that the business was worth trying; but if they should be unlucky enough to meet with misfortunes, the result was only their failure, and the loss came upon the insured, since the actual capital contributed to the company was very little, only enough to pay the expenses of trying the experiment. So numerous were the instances of these insurance speculations, and so disastrous were they to the public who had been deceived by them into supposing that the security could be gained by paying for the policies they issued, that public attention was roused, and measures were proposed for legislative action, by which the governments of the states in which insurance agencies were established should have some control over them, and, in the interest of the public, prevent such companies as were unworthy of confidence from seeking to gain it.

From this arose the establishment of insurance departments in some of the states, Massachusetts having inaugurated this movement, and New York having perfected it. The experience which New York had acquired by a similar supervision exercised over the banks of the state made her more ready to apply the same method of control to the insurance companies, and more readily aware of its advantages. The very essence of fire insurance is security and stability. A company which fails when the crisis comes, for which it pretended to be a safeguard, is worse than no company at all, for it doubles instead of diminishing the loss by fire. The insurer, who has taken out one of its policies, finds, when his house has burned down, that the security he thought he had is worthless, and that he has thrown away the premiums he has paid.

To perform for the public the same office with regard to its insurance policies that it does with respect to its bank-notes, that is, to provide that the public shall not be liable to being cheated in them, is one of the legitimate functions of the government, and is especially so in a republican government, which should be in fact, as it is in theory, the agent of the public, delegated to perform

just such duties as these, for which individuals are necessarily incompetent.

By the working of this innovation, the danger of speculative fire insurance companies has been as nearly done away with as is possible with a system of insurance based on individual companies competing for the business. That absolute security is not gained by such a system, even with the supervision of a state department, is shown by the recent terrible catastrophe at Chicago.

From the report of the State Superintendent of the Insurance Department, made the 11th of November, 1871, and based upon statements returned from the companies in answer to a circular calling for them, it appears that twenty companies, organized under the laws of the State of New York, had ceased to do business, and gone into liquidation. The loss by this single conflagration, supposing that the entire assets of the New York companies which ceased business in consequence were absorbed to meet the loss, and adding that incurred by other companies, which still continued solvent, was in the State of New York alone $20,724,457. The aggregate loss of all the insurance companies doing business in this country, including six foreign companies, was $88,634,122, which was divided among three hundred and forty-one companies, having as their total assets $145,879,521, which shows that by this single catastrophe they lost one half their assets.

Such a crisis as this calls attention to the proposition which was made a few years ago in the British Parliament by Mr. Robert Lowe, that the government should assume the business of a general insurer for that country. At the time when this suggestion was made it excited but little attention, being passed over as either unwise or premature ; but by the light of the Chicago fire, it is made plain that it requires the collective wealth of a nation to meet the strain of a catastrophe like this. Besides, too, the economy introduced into the administration of the business, if the nation's insurance were conducted by one bureau, instead of by hundreds of different companies, each with its numerous officers to support, would in fifty years — and such an occurrence would most probably not occur oftener — prove enough to make up even such a gigantic loss. At the same time also if insurance was made, in the hands of the government, universal, the rates charged would need be so much less than those now found necessary, as to itself provide sufficiently to meet such catastrophes when they occur.

LINEN FIRE HOSE.

THE FIRE ENGINE BEFORE CHRIST. — CTESIBIUS AND APOLLODORUS. — HOSE INVENTED BEFORE ENGINES. — QUANTITY OF LOSSES BY FIRE. — GREAT FIRES. — ROME TO CHICAGO. — FIRST MODERN FIRE ENGINE IN GERMANY. — "HAND-SQUIRTS" IN LONDON. — VAN DER HEYDE'S LEATHERN HOSE. — NEWSHAM'S IN ENGLAND. — ADVANTAGE OF HOSE. — USES OF HOSE OTHER THAN AT FIRES. — MILLS, HOTELS, RAILROADS, STEAMBOATS, GARDENING, SIDEWALKS, HYDRAULIC MINING. — LEATHER AND WOVEN HOSE. — THE RUBBER-LINED LINEN HOSE. — MODE OF MANUFACTURE. — STRENGTH. — TESTIMONIALS. — SUCCESS OF THE NEW ARTICLE.

THERE is a statement that the Greek mechanician, Ctesibius, who lived 250 years before Christ, "is believed to have invented a kind of fire engine." The earliest distinct reference, however, known in history, to any mechanism for the extinction of conflagrations, does not make mention of anything like an engine, pump, or syringe, but of a hose with a compressible bag to hold the water. This reference is found in the writings of Apollodorus, an architect, who flourished in the reign of the two Roman emperors, Trajan and Adrian, in the second century of the Christian era; and it is worthy of remark that, as in the case of so many other ingenious suggestions, it was first made in the interest, not of peace, but of war. Apollodorus suggested that, for the purpose of preventing harm from the fire-darts, which were then sometimes flung into fortified places by the attacking forces, a good plan would be to use the intestine of an ox, with a bag full of water attached, so that the squeezing of the bag would lead and drive the water out, and thus extinguish fire at heights where the hands of men could not reach it.

The enormous quantity of property and the great numbers of lives which have been lost by fires, if the story could be told so as to be within the grasp of the mind, would form a most impressive exhibition of the helplessness of humanity. In ancient times, and even recently in Oriental cities, thousands of lives have been lost at a single fire, as at London, in the year 1212, where over

three thousand persons perished. From the burning of Rome, under Nero, down to the tremendous Chicago fire, of October 8 and 9, 1871, great fires have stood high in the awful roll of human calamities. The number of fires of importance enough to have been put on record, so as to have become part of local and often general history, is enormous. In or near London alone there have been a hundred and sixteen "remarkable" fires, of which the "Great Fire" of 1666 burned four days, devastated four hundred and thirty-six acres, including four hundred streets and thirteen thousand two hundred houses, of which eighty-nine were churches; it made two hundred thousand persons houseless, and destroyed fifty million dollars' worth of property. The number of fires now happening in London *every year* is two thousand or more, but very few of them do great damage. Since that time no fire has been equal in extent and destructiveness to that at Chicago, which swept a space four miles long and nearly two broad, flung a hundred thousand persons shivering out upon the prairie, the streets, or the lakes, and annihilated at least two hundred million dollars of values accumulated by human labor. Many a conflagration of but small extent has carried into nothingness books, manuscripts, relics of antiquity, illustrations of history, and remembrances of famous men and women, which no price could equal or replace.

The first improvement on the obvious and immemorial practice of carrying and pouring water in whatever vessels were at hand was a pumping machine, not so very different from a small, weak, hand fire engine of the present day, without any air-chamber. Something of the kind was in use in Germany early in the sixteenth century. Almost a hundred years later than this, however, nothing better seems to have been used in London than a sort of big brass "hand-squirts," as they were called, being syringes that would hold two or three quarts of water, and which were held and pointed by two men, while a third worked the piston. They were filled at a tub of water.

None of these machines, however, could have any effect on any fire beyond the distance to which they could throw water, nor was there any suction arrangement. Water had to be brought to them. Hose, for drawing water into the machine, and also for leading the supply of water to more distant parts of a conflagration, were first invented by two Dutchmen, named Van der Heyde, in Amsterdam, about 1670, and a similar device, very likely copied from theirs, was introduced into England by one Newsham, who patented an

"improved fire engine" there. These hose were on the same general plan that has been in use ever since, and is still a good deal used to-day. They were made of leather, — sewed, most probably, instead of riveted, — and the suction lengths prevented from collapsing by being made of extra strong leather, with the reënforcement of a strong, spiral piece of metal running through the inside.

The usefulness, and indeed indispensableness, of hose as a means of applying the most improved modern resources against fires, have been most fully proved since the introduction of the steam fire engines, which have become so numerous since the first Cincinnati engine was turned out, in 1853, by Mr. Latta. These beneficent giants, which so ingeniously fight fire by means of fire, depend very greatly on the immense space of ground over which their hose enables them to distribute their vast and incessant cataracts of water. This space is at least ten times as great in every direction as could be commanded by the stream from the engine itself; so that the whole area thus made accessible by the use of hose is about a hundred times as great as without it.

It must not, however, be supposed that the use of hose for city fire departments is its sole use by any means. Great quantities of it are required in manufactories, both in cities and out of them, as no large mill, whose work exposes it to any risk of fire, is properly fitted up without a good head of water and an abundant supply of hose, provided independently on each floor, so that a powerful stream may be quickly thrown on the first beginnings of fire. Many large hotels require similar fixtures. A good deal is also used for similar and other purposes by steamboat and railroad companies; a further extensive market arises from the use of hose for watering gardens and sidewalks; another still, and quite an important one, originated in the modern system of "hydraulic mining," by which water is carried, sometimes from great heights, through hose, and fired, so to speak, through a nozzle against earth where gold dust is supposed to be found. This tremendous and destructive system of mining devours whole hills, and sifts out their precious contents with a strange rapidity. Now seventy thousand feet of hose is no very great quantity to be used by the fire department of one city; many large mills would require from eight to twelve thousand feet to equip them thoroughly against fire; and when we consider the great number of our large cities, the far greater number of our factories, besides railroads and

steamboats, and lastly, the quite incalculable multitude of smaller individual demands, we shall quickly be convinced that the aggregate of transactions in the hose business is very considerable.

Leather was for a long time considered, on the whole, the best material for hose, while at the same time its heavy first cost, and its rapid decay under use, were recognized as serious objections. These defects, moreover, increase in importance from year to year, as leather grows more and more expensive from the rapid consumption of the forests, which furnish oak and hemlock bark for tanning. Various substitutes have been tried, but none of them have given much satisfaction, until the introduction of the rubber-lined seamless linen hose, at present manufactured by the New England Linen Hose Manufacturing Company. This company, consisting of Messrs. Erdman Bauch, Charles H. Proessdorf, and F. W. Claessens, Mr. Claessens being treasurer, has a factory on Longwood Avenue, Boston Highlands (i. e., Roxbury), Boston, Mass., and an office at room No. 4, 179 Washington Street, in the same city. This company manufactures seamless linen hose and cotton hose of all sizes, from three fourths of an inch up to ten inches in diameter, and the same, rubber lined, from three fourths of an inch up to six inches in diameter.

These seamless hose are woven round and round, stocking-fashion, but with a web like that of cloth, not with a knitting-stitch. Such hose have been used as leading-hose at fires in Germany and France for more than a quarter of a century, but the first attempt to manufacture the article in the United States was made in 1856. The weaving is done in a stout loom, not very different from an ordinary cloth loom, but with a very heavy leaden beater, for the purpose of driving the threads closely together. The thread used for the heavier hose is a stout linen cord, of the best Irish or Russia flax, imported expressly for the purpose, each thread consisting of fifteen strands, and being able to support a weight of seventy-five pounds. The result is, a fabric compared with which the heaviest sail cloth is as muslin, and one does not wonder, while handling the dense and solid texture, at hearing that it is warranted to bear a strain of four hundred pounds to the square inch, equal to nearly five tons on the area of a man's hand.

Even this tough web, however, will "sweat," i. e., will permit the gradual escape of water through its interstices when subjected to the great strain that is necessary at fires; and a peculiarly ingenious mode has been devised, which is embodied in one of the

patents under which the company works, — bearing date of June 23, 1868, and known as Forsyth's patent, — for preventing this sweating. A tube of India rubber is made just small enough to draw snugly into the inside of the linen hose. When in, the ends, in lengths of fifty feet, are made fast together, one end of the double tube is made tight, and through the other, steam, at a considerable pressure, is let into the pipe. The steam expands the rubber, and squeezes it so forcibly against the linen behind it that the two are cemented intimately together, the India rubber being driven well in among the fibres and interstices of the linen. The severest pressure entirely fails to cause any "sweating" in the hose thus made. The company manufactures cotton as well as linen hose, if ordered, but it is not an equally good article, though cheaper.

The American Institute, at its exhibition in New York in 1869, awarded to the New England Linen Hose Manufacturing Company a medal and diploma for its linen hose; and from its customers it has received numerous and conclusive testimonials to the merit of its productions. A specimen or two of these are worth printing.

"FIRE DEPARTMENT OFFICE, CITY HALL,
BOSTON, September 13, 1869.

"F. W. CLAESSENS, *Treasurer New England Linen Hose Manufacturing Company.*

"DEAR SIR: I received from you one hundred feet of your two and one half inch linen hose, August 18, 1868, for trial in this department, and placed the same in charge of Engine Co. No. 6.

"This hose has been in constant use for one year, stood the pressure to which it has been subjected to in actual duty, and only burst after having been run over by one of our heaviest engines, at a pressure of one hundred and fifty pounds. If its powers of endurance will equal its strength, it will be the most desirable hose for steam fire engines, having the advantage of lightness and flexibility over all other hose in use in this department. Up to the present time it has performed all you claim.

"Yours, very respectfully,

"JOHN S. DAMRELL, *Chief Engineer.*"

"NACOOCHEE, WHITE COUNTY, GA., March 17, 1870.

"F. W. CLAESSENS, ESQ., *Treasurer, etc.*

"DEAR SIR: We have been using your seamless linen hose, six inches in diameter, constantly during the past sixteen months,

under a pressure of from fifty to one hundred and twenty-five feet, and are much pleased with it. As an evidence of this fact, the secretary of our company, Mr. Frederick Beck, has ordered a further supply to take the place of cotton hose, which is giving out.

"Yours truly,

"Samuel N. Bosworth,

"*Superintendent Nacoochee Hydraulic Mining Company.*"

"Claremont, N. H., October 3, 1871.

"C. K. Sanborn, Esq., *Chief Engineer, Rochester, N. H.*

"Dear Sir: In answer to your inquiry about New England Rubber-lined Linen Hose, I would say that the town of Claremont purchased, in June last, one thousand feet of the hose, and like it very much. We tested it with a force-pump that would burst any hose that we had before, and it made no impression upon it. We had no means of telling how much the pressure per inch was.

"We think this hose superior to any other kind in use, but have not had it long enough to say how durable it is.

"Very respectfully,

"H. E. Barrett, *Chief Engineer.*"

These letters have peculiar weight, since they are from official persons whose positions and duties give them the best possible means of forming opinions, while at the same time they are by necessity equally cautious not to commit themselves to the indorsement of any untested novelty. There is a further significance, moreover, in the fact that a very strong effort would naturally be made by the parties who have controlled the supply of leathern hose to the various fire departments of our cities and towns to prevent a change so dangerous to their established interests. The makers of India rubber hose would naturally decline to admit the superiority of the new combination of India rubber and linen; and thus the new invention has had to fight its way up towards general use against a pretty numerous and determined set of opponents. At present, however, the reputation of the rubber lined linen hose is well established, although the company began operations no longer ago than in 1868, and there is steady and increasing demand for it, as well as for the plain linen and cotton hose themselves, without the rubber lining.

THE TREASURY.

THE CHANGE IN THE MODERN FINANCIAL METHODS FROM THOSE OF ANTIQUITY. — THE METALLIC CURRENCY OF ANTIQUITY. — THE MONEY WHICH IT REPLACED. — THE TREASURY IN ANCIENT TIMES. — THE MONEY OF THE PRESENT. — THE POSITION OF THE TREASURY IN MODERN CIVILIZATION. — PAPER MONEY ISSUED BY GOVERNMENTS. — THE CONTINENTAL CURRENCY. — FRENCH ASSIGNATS. — THE NEW YORK BANKING SYSTEM. — THE NATIONAL BANK SYSTEM. — THE COST OF THE CIRCULATION THEY PROVIDE FOR THE PUBLIC. — GREENBACKS. — OBJECTIONS TO A PAPER MONEY. — DIFFERENCE BETWEEN A PAPER MONEY AND A MONEY OF PAPER. — PURCHASING POWER THE TEST OF MONEY. — A STABLE MONETARY STANDARD. — HOW BEST TO ATTAIN IT. — THE SELF-REGULATING SYSTEM OF THE MINT. — THE SYSTEM PROPOSED BY VICTOR CONSIDERANT. — OTHER PROPOSED SYSTEMS. — THE TREASURY IN THE FUTURE.

The industrial activity of our modern life, which differs so materially in its intensity and varied character from that of antiquity, is yet not more distinct in its methods than are the financial systems of to-day as compared with those of the early periods of historic times. In the development of industry, we have seen, in this volume, how the reliance of mankind upon their unaided muscular energy has been replaced by the use of steam, and its application to machines of an apparently intricate complexity, but which are all only modifications or combinations of simple elements. By this means, humanity in its progress towards the domination of this planet, has obtained a power, together with a knowledge and control of the laws of physical nature, which, to the pre-historic man, would have appeared impossible. In glancing hurriedly over the evolution of our financial methods, which are so important as an expression of the advance in social organization, we will see that the same general tendency has been preserved, and that the growth has been towards universal methods; towards obtaining a knowledge and control of the laws of finance, and in this branch of investigation the history of the position and influence of the treasury forms naturally a chapter of this work.

Among the nations of antiquity the only money in use was made of gold and silver, or some alloy of the metals, such as brass or bronze. This single fact is sufficient to show that their industry, their social condition, and their political organization had reached only a rudimentary stage of development. The savage, whose tools are only sharpened stones, cannot, we know, have made any great advance in his industrial methods, and it would be as impossible for the modern world to retain its social and political relations were it forced to depend upon a simply metallic currency, as it would be for it to manufacture the products of its industry, were it forced to depend for its tools upon only the flint axes and other similar appliances used during the stone age ; and though the actual amount of gold and silver in the world has been increased from the new sources of supply discovered in quite modern times, by an amount greater than the entire quantity in the possession of the nations of antiquity, yet if the modern world was forced to depend solely upon this as a currency, or a measure of value in its exchanges, trade and industry would be arrested as completely as though the use of steam was as suddenly abrogated, and mankind was obliged to return for the sources of the force we require for our industrial operations to our own muscular energy, supplemented only by that of animals.

That gold and silver should have been used exclusively as the material for the currency during antiquity, was as natural as that stones should have been used as the material for edged tools, before the ability to work the metals had been gained by the increased experience of generations ; but to attempt to make them subserve the needs for a measure of value by which to regulate the commercial and financial operations of the modern world, is like undertaking to manufacture the steam engines needed for the work of the world with the flint adzes of pre-historic times. In fact the use of gold and silver for the currency was itself an advance upon the previous use of other less suitable materials for the same purpose. The Latin word for money, *pecunia*, shows, in its derivation from *pecus*, a domestic animal, that during the pastoral stage of the social development of the tribe from whom the Latins derived their language, cattle, as the most generally possessed evidence of wealth, were the established measure of value ; and the conception that our modern paper currency should be based only upon the possession of a certain amount of gold and silver, is as illogical as it would have been upon the introduction of a

metallic currency to have claimed that its coinage should be regulated, not by the demands of the public, but upon the possession of a certain amount of cattle.

The chief material used for the currency of the modern civilized world is paper; and though the financial organization of no civilized nation as yet recognizes this fact, yet the exigencies of our industrial activity have forced its practical acceptance upon the commerce of the world. The money thus in use is paper money, and is subject to the same objections, in a more modified degree, that a metallic money is inherently liable to. It can be monopolized. The necessity of our modern industrial activity is for a money that shall not be subject to this objection, and as the greater convenience of paper makes this material peculiarly fitted for monetary purposes, there is no question but that our future currency will be made of this substance. It will not be paper money, but a money of paper, and its value will not be based upon any arbitrary standard, but upon the needs of our industry for its use.

Among the nations of antiquity the state treasury was the storehouse in which were kept the amounts of gold and silver coins which the government had gathered from its subjects by taxation, or had captured in war, or had wrung from conquered nations as a tribute; and the only business of the treasury was guarding the accessions made to these, disbursing the amounts necessary for the expenses of the government, and keeping an account of the balance on hand. Up to quite modern times the functions of the treasury have been confined chiefly to similar duties, though with the use of paper money, and with the era of national debts, gold and silver have ceased to be the only representatives of value, the custody of which has been intrusted to the treasuries of various nations.

Gold and silver being still, however, the basis of value for the currencies of the various nations, it is to the mints that the preparation of the metallic money is intrusted; the issue of the paper money being placed in the hands of various financial institutions, which are more or less under state control. The Bank of England, the Bank of France, and our own national banks, afford examples of the financial organizations of these various countries which are relied upon to provide the chief portion of the paper currency required by the people for the transaction of their daily business. In the revolutionary crises which, during the last century, have attended the passage of civilization to a higher plane of political

and social organization, the exigencies of the situation have forced the governments to provide a currency for circulation. The chief instances of these attempts have, as was natural, been furnished by France and the United States, the two countries in which the democratic movement of the modern world has most vigorously asserted itself. The first of these was in our revolution of 1776, which gave rise to the continental currency. This currency was such as it seemed alone possible to make under the circumstances. Many of the colonies had before issued paper money for the purpose of meeting the extraordinary expenses of wars with the Indians, and their individual credit stood high enough to enable them thus to borrow money, since there was no question of their eventual success, and that they could be relied upon to meet the obligations they thus incurred. With the revolution, however, the case was different. The contest appeared hopeless, and the colonies at that time were far from having any spirit of national unity. The bills, therefore, issued by Congress, continued to depreciate, until they became practically worthless, and ceased to have any value as a money.

With the advent of the French revolution of 1793, the same necessity arose for the issue, by the government of the time, of paper money. There was, however, a stable basis for the issue of this currency. The revolutionary government had suppressed the monasteries of France, and confiscated their lands, together with many of the estates which had belonged to royalty and to the nobility. The land which thus passed into the possession of the government, as a representative of the people, was made the basis for the issue of the *assignats,* as the currency thus introduced was called. By the public sale of these lands at auction, and by taking the pay for them in assignats, it was expected that these would obtain and maintain a circulatory power, which would make them a valid currency. A combination of various circumstances, however, made the sale of the lands impossible. The chief of these was a fear that the revolution would not be successful, and that lands thus purchased would be forcibly retaken ; and also a prejudice, which had great force in preventing their sale, that the purchase of lands confiscated from the church would inevitably bring disaster and death to the purchaser. In consequence the assignats, like our continental currency, speedily commenced to depreciate, and continued to do so until they became practically worthless as a circulating medium of exchange.

The unsuccessful results of these two attempts to introduce a circulation without a metallic basis, produced a prejudice against paper money issued by a government through its treasury department which has not yet died out, while at the same time the innovation of such a system of currency stimulated the study of financial methods, and showed the importance of a correct comprehension of the monetary system as one of the chief forces in the social organization, and perhaps the most important one in the distribution of the results of industry.

During the early part of this century the industrial activity of the United States demanded imperatively for its uses a larger amount of a circulating medium than the coinage of the country could provide. To supply this need, numerous joint-stock banks of issue were formed, and, especially in the newly settled portions of the country, were managed with great recklessness, and frequently to the great loss of the public. Notwithstanding, however, the evils incident to the irresponsible character of the circulation which the joint-stock banks furnished to the public, there is no question but that the possession of the medium of exchange they afforded to industry did much to stimulate its activity, and was one of the chief influences in producing the unexampled progress of this country during the past fifty years in all the evidences of actual wealth. It gave to industry the means of exchanging its products, and, as all wealth is produced by industry, the houses, the crops, the towns, the manufactured products of all kinds, of which this nation is so justly proud, are in a great measure due to the operations of the currency furnished by the banks. It is true that this currency was defective, that it was irresponsible, and that the ease with which it could be monopolized, was the cause of frequent financial crises, with all the disorganization and loss consequent upon such a condition of things. But yet it furnished the medium for exchange which industry requires as absolutely as it does tools for its manual work, and, in default of a better, it was forced to content itself with this. Still, however, the evils of its irresponsible character, when made so plainly evident by the species of financial epidemics which seemed to periodically attack the banks which issued it, causing them to fail, and making their bills a partial or entire loss to those who held them, impressed upon the public the necessity of instituting some method which should obviate this fault, and New York State has the credit of originating a banking system which made the circulation they issued perfectly

stable and safe in the hands of the public. This simple device was as follows: No bank was allowed to issue any bills unless they were signed by the state comptroller, who thus signed amounts for the respective banks only when they had deposited with him either national or state bonds to the amount of the bills they desired.

In consequence of this provision the actual bill holders were made perfectly secure; since, even though a bank should fail, through mismanagement or fraud, yet the state comptroller had in his possession securities sufficient to redeem all the bills it had issued. This system was so successful in its working that the bills of the New York State banks circulated freely and at par all through the state, and elsewhere, wherever the system was understood.

With the advent of the war for secession, another financial crisis came upon the government. With the enormous increase in its expenditures, some method became necessary for obtaining the money needed to meet them, and as the uncertainty of the result of the contest naturally injured the credit of the government, some means had to be devised for enabling it to sell its bonds on reasonable terms. From this necessity arose our national bank system, which is simply an extension of the organization of the New York State banking system to banks chartered by the general government. The banks which invested their capital in United States bonds, deposited these with the treasury, and, while drawing interest upon them, obtained the right to circulate a proportionate quantity of notes which were furnished them by the treasury, and countersigned by its officer. By this means the circulation of the national banks was made secure in the hands of the holders, since for each bill issued, the government, through the treasury, had in its possession securities for this very purpose. In consequence, therefore, the circulation of the national banks is stable, since it is not irresponsible, and passes all over the country without question and at par. For the first time in our history we have a circulation of paper money which, from Maine to Oregon, is the same, and the loss from discount and fraud, which was so serious an evil of the irresponsible circulation formerly provided by the joint-stock banks, has been done away with. But great as are the advantages of the national bank system, it does not entirely fulfil all the conditions necessary in a circulation. It is stable; but it can be monopolized, and it is too expensive to the public.

On the first of April, 1871, the amount of the notes in circula-

tion, issued by the national banks, amounted to $313,403,861, while at the same time the amount of the notes issued directly from the treasury, or the "greenbacks," was about $397,000,000, making the amount of the currency in circulation about $710,000,000; or, estimating the population of the United States at about forty millions, not quite eighteen dollars for each of us. The estimated amount of currency, made by many European economists, as sufficient for the daily needs of the people, was sixteen dollars to each person. Here, in this country, from the greater activity of our industrial life, and the freedom of our political relations, a larger amount is needed. Twenty dollars in each one's possession means only a week's support; and it is not desirable in a republican government to have the mass of the people as near actual want as money enough for only a week's support implies. But supposing that an average of twenty dollars to each of the population is enough, this would make $800,000,000 the amount required for the circulation, or ninety millions more than is now in the hands of the public.

The amount of the currency, as we see, is made up of two items — national bank notes and greenbacks. The basis for both of these is the same, — that is, the credit of the government; or, in other words, the collective wealth of the whole people, and the results of all our industry. With the national bank notes, this is represented in the bonds of the government deposited in the hands of the treasury; with the greenbacks, it is the credit of the government directly, without this intervention.

The amount of the national bank notes in circulation is represented by an equal amount of United States bonds deposited in the hands of the treasury, and upon which the industry of the country pays a yearly interest. This amounts, at seven per cent. upon $313,403,861, to very nearly $22,000,000 a year. Serious as is this charge, it is not all that the public pays for the use of this currency based upon its own wealth. The banks which have these notes furnished them by the government, and printed at its own expense, charge the people among whom it circulates interest for its loan. This makes another yearly charge of $20,000,000, so that the use of this circulation furnished the public by the national banks costs to the industry of the country $40,000,000 a year, which the people must pay outright into the hands of the banks. It is evident, therefore, that this circulation furnished by the national banks is too expensive; and when it is also remembered

that this system gives to the banks an immense power of monopoly, which they are not slow to use, the necessity for a change becomes even more evident.

At the time of their creation, during the crisis of the war, the national banks did unquestionably good service to the country, and deserve well of it. But so did the army ; and yet, when the necessity for its use was past, it was disbanded, and no one claimed that the gratitude of the country should be forever taxed to support it for the service it had done. It is the same with the national banks. They have performed their function, and, like their predecessors, the irresponsible joint-stock banks, they must give way for a better, a cheaper, and a more efficacious system, which, for these very reasons, is more in accordance with the democratic growth of our social and industrial organization.

This system would consist in having all our currency issued by the treasury. In this way the currency would be stable, since it would be responsible, and its monopoly would be impossible, since it would be in the hands of the nation. As the coinage of a metallic currency has, by the development of political organization, been taken from the hands of the kings and relegated to the mint, as a national institution, so must the providing of a money of paper be relegated to the government, as the agent of the public, from the hands of private corporations.

One of the chief objections which will be urged against such an innovation will arise from the prejudice against what is called "an irredeemable paper money," and which arises partly from the unsuccessful attempts in France and this country, to which allusion has been made above, and also from the species of traditional reverence for gold as a monetary standard. This last mentioned feeling is akin, in finance, to the traditional reverence for royalty, in politics. There are many persons yet in the world who suppose that, in the one case as in the other, there is a kind of mysterious, and possibly supernatural, quality inherent in gold, as in a king, which has a wonderful influence in producing order and stability. To such persons history is a sealed book, all analogy is nonsense, and argument is thrown away. But the fact is, that an irredeemable currency is what the world needs. Such a currency has never been seen, and the objections to our own present currency furnished by the treasury is, that it pretends to be redeemable, while it is not. It is a paper money, and not a money of paper. The greenback does not pretend that it *is* a dollar, but

only that it can be exchanged for a dollar, and, in consequence, cannot be expected to be worth more than a dollar.

A gold dollar is a coin, containing a certain weight of gold of a certain fineness, the amount and degree of which are settled by act of Congress. But the public are not specially interested in this; what they want in a dollar is, that it shall have a certain purchasing power, and to them the value of the dollar lies in the ability it thus has of being exchanged for whatever other product of industry the holder of it desires to possess. To possess this permanently is impossible in the case of gold, since any increase in its quantity must lessen its value, while any scarcity must increase it. It is well known that the increased amount of gold brought into the circulation from the deposits discovered within this century has lessened its value materially.

The problem how to obtain a standard measure of value, which shall be constant and unvariable, is a most difficult one to solve, and has exercised the attention of the best thinkers upon financial matters. One of the most brilliant and valuable contributions of science to the knowledge of the modern world is the scientific unit of weight and of length which the experts in such investigations have given us; but as yet there is no standard monetary unit which is constant in every change of conditions. The best and most scientific method proposed for arriving at this value of the abstract monetary unit, the dollar for example, is one given by Mr. Victor Considerant, in a letter to Secretary McCulloch. His proposition is, that an average be made of the purchasing value of a dollar from the chief crops of the country, for five, ten, twenty, or a hundred years, if necessary, and that this average shall be fixed by law as the standard value of the dollar. Then, as the stability of a currency comes from the correlation between the supply and demand, the government has a constant test by which to decide whether the issues are too small or too great. Should the dollar at any time be found to have less purchasing power than the average dollar agreed upon, then there are more dollars in circulation than the needs of the public require, and the currency should be contracted until the dollar has acquired the requisite purchasing power; if, on the other hand, the purchasing power of the dollar is greater than the average agreed upon, then there are not enough dollars in circulation to satisfy the needs of the public, and enough more should be put into circulation to reduce its value to the fixed standard. By this self-regulating system, the value

of the money of paper issued by the treasury would be kept as constant as that of the gold coinage issued by the mint, and from an analogous cause.

The infusion of the democratic spirit into our political relations has made the mint a self-regulating institution. While the coinage of money was in the hands of royalty, nothing was more common than debasing the currency as a device for raising money for the king's private purse. By making a thousand dollars' worth of gold simulate the value of two thousand, the royal coiner pocketed the difference. Finally, however, the growing spirit of popular freedom demanded that the mint should be managed in the interest of the public, and with this change honesty and justice are inherent in its operations. If the coinage is made baser than the standard, it will not circulate except at a discount; if it is made better than the standard, the brokers and jewellers buy it up and melt it over for the gain they can thus make. The stamp of the mint is, therefore, a guarantee of honesty, and is everywhere accepted without question. The same thing could be done with the issues of the currency from the treasury, and the dollar of paper could be given as accurate and stable a value as the dollar of gold.

Whatever may be thought of the value of this system, and it requires some previous training in such subjects of consideration, before any one is capable of forming an intelligent opinion about the matter, yet there is no question that it has the merits of a system which is consistent with itself, and a treasury thus managed would have a method for its action, and a test for what it should do. In this respect, at least, it would be a great improvement upon the want of method which now characterizes the management of the treasury. In fact, at present, this important branch of the national service is conducted very much as though the influence of the treasury upon the price of gold was the sole object for which it was instituted, and the measures taken by those in control to produce the ends they desire, are as though an engineer should attempt to control the steam engine under his care, not by handling the valves which regulate the admission of the steam, but by pushing or pulling on the balance-wheel.

The attention given to economic science in modern times has resulted in the suggestion of other systems for the management of the treasury, which it will not be amiss to notice here. The students of political economy are fully aware of the importance

of financial systems in matters of social and industrial organization, and how desirable it is that the popular intelligence upon such subjects should be accurate, and infused with a wise distrust of mere precedent, since only as the intelligent desires of the public are expressed in political action can it be hoped that the systems in operation will be modified to suit the changed conditions of the times.

Another system was proposed by Mr. Edward Kellogg, in a work published first in 1849, and again in 1861, under the title *A New Monetary System.* In this work he proposes that the currency of the country should be issued by the government, and based upon the real estate of the country, since the value of the improved real estate is the best test of the wealth of a country. According to this system any owner of real estate should have the right to obtain a loan from the government of one half the valuation of the property. This loan should be given in the currency, for an indefinite period of time, and at such a rate of interest as would suffice to pay the expenses of organizing and conducting the business, at most probably rather under than over one per cent. interest. In this way he maintains that the volume of the currency in circulation at any one time will represent the necessities of the industry of the country. No one will desire to thus borrow from the treasury unless he can make a profitable use of the money, and of his need for money, and his ability to use it, each man is his own best judge. The arguments by which Mr. Kellogg sustains his suggestions, and the statistical proofs he brings to show that the present rate of interest is so much higher than the average rate of the profits made by industry over the expenses of living, as to threaten the absorption of the country's wealth into a few hands, and is the chief cause for the unequal distribution of wealth, are well worthy of careful consideration from every one.

Another proposition, by which the currency shall be made so readily accessible to all that it cannot be monopolized, consists in the suggestion that the government should issue through the treasury a sufficient quantity of bonds to provide the amount of the currency required by the industry of the country, and that these bonds should draw only a low rate of interest, say three per cent. a year, and that to any one who deposits these bonds as collateral, currency of a certain proportionate value shall be lent at the same rate of interest, all loans to be settled within a year, so that each year's products shall pay each year's loans.

The working of this system, it is claimed, would be, that it would prove self-regulating. Whenever opportunity offered, and of this the public, each man acting according to his own knowledge of his own interests, is the best judge, currency would be called for, and when the time for its profitable use had passed, the currency would be returned for bonds. Further: this currency would be stable, because it would at any time represent the demands made for it by the industry of the country, and it would also be impossible to monopolize it, while it would not cost too much.

It would, perhaps, not be wise to adopt either of these suggestions entirely, but all of them are valuable as indicating the modifications of our financial system which shall make the treasury what it should be, the centre of the circulation of the body politic; and it is manifest to every one who has studied the spirit of the times, and investigated with a method the course of the changes which this century has brought about in our social and financial organizations, that some such system is needed for satisfying the demands of the industrial activity of the times, which, with its methods of steam transportation and telegraphic communication, has outgrown the financial systems which were competent for the last century.

CHURCH ORGANS.

THE DERIVATION OF OUR WORD ORGAN. — THE HEBREW WORD TRANSLATED "ORGAN," IN THE BIBLE. — THE INSTRUMENT TO WHICH IT PROBABLY REFERS. — THE WIND INSTRUMENTS OF THE GREEKS AND ROMANS. — THE COMMENCEMENT OF THE MODERN HISTORY OF THE ORGAN. — VARIOUS MENTION OF THEM IN HISTORY AND LITERATURE. — THE GROWTH OF IMPROVEMENT IN THEIR CONSTRUCTION. — REFERENCE TO THE LITERATURE ON THE SUBJECT. — ORGAN BUILDING IN THE UNITED STATES. — THE SENTIMENTS OF THE EARLY SETTLERS AGAINST THE USE OF INSTRUMENTAL CHURCH MUSIC. — THE FIRST ORGAN USED IN AMERICA. — THE FIRST ORGAN BUILT IN AMERICA. — THE FIRST AMERICAN ORGAN BUILDER. — HIS SUCCESSORS. — THE PROGRESS OF THE ART.

Our word *organ* is derived from the Latin word *organon*, meaning an instrument, but has in its application become confined simply to designate the instrument which confessedly occupies the chief place in the various musical instruments; as the word *Bible*, which means simply *book*, has come to be applied only to the volume which is considered the most valuable of books.

The word *organ* occurs several times in the Old Testament, as the translation of the Hebrew word *'ûgâb* or *'uggâb*; which, as its root indicates, most probably denotes, in reality, a pipe, or some other perforated wind instrument. In *Genesis* iv. 21, it appears to be applied as a general term for all kinds of wind instruments. In *Job* xxi. 12 are enumerated the three possible kinds of musical instruments, under the general terms of the timbrel, harp, and organ. The translators of our version took this term *organ*, here, from the Vulgate, which has uniformly the word *organon*, that is, the double or multiple pipe. Many commentators of authority agree in the opinion that the term refers in reality to the instru-

ment known as the Pan-pipe, or syrinx, which was unquestionably known in the East at a very remote antiquity.

The analogies of invention and social advance in modern times would tend to show us that a pastoral people like the Hebrews, at the time mentioned, could not have arrived at the invention of anything like so complex a musical instrument as the organ of the present day, and that most probably the musical instruments they possessed were only some species of quite rude and simple pipes, such as many nations of the same culture at present possess.

Among the Greeks and Romans the pipes in use were of the simplest kind, the wind being always obtained by blowing into them from the mouth. The first step of invention in the direction of the modern organ must have been the application of some other appliance to the Pan-pipe than the human mouth and lungs, for supplying it with the necessary current of air. Exactly, however, when this first step was made, we have no record.

About the middle of the third century before Christ, Ctesibius is said to have invented an instrument called the *hydraulicon*, or water organ, while some writers of the time mention a pneumatic organ, or one which worked with air. Whether these were the same, or in what their differences consisted, we have no means of judging, since there is no record of their method of construction.

On an ancient monument in the Mattei gardens at Rome, there is said to be a carved representation of an organ, which, in its form, the operation of its keys, and the use of the bellows, is said to resemble the organs now in use. St. Augustine in his commentaries on the fifty-sixth Psalm, which were written about the year 400, alludes to an instrument which was furnished with bellows for its supply of air.

The introduction of organs into the churches of Western Europe is said to have been the act of Pope Vitalian, about the year 670; though the first trustworthy account of an organ is to be found in the record of one which was sent to King Pepin in 755, by the Byzantine Emperor, Constantine Copronymus.

In England organs are said to have been quite frequently met with even before the tenth century; and to have been at this period larger than those to be found on the continent. Elfeg, the Bishop of Winchester, had a very large one in his cathedral in 951.

At this time, however, organs were very rude and simple in their construction, and of very small capacity. The keys, it ap-

pears, were intended to be struck with the fists in playing, and were consequently made sufficiently broad and large. The pipes were of brass, and harsh in tone. As late as the twelfth century it is most probable that no organ had a compass of more than twelve or fifteen notes, though about this time half notes were introduced into organs made in Venice.

Some of the instruments made at this period had an arrangement by which concords could be produced, so that the touching of certain notes produced not only its own sound, but also its fifth and eighth. In 1143 William of Malmesbury, the English historian, who was also precentor, or leader of the choir in the monastery of Malmesbury, mentions an organ in which the wind, "forced out by the violence" of boiling water, "passing through brass pipes, sends forth musical tones." This would appear to have been the precursor of the steam organ or calliope, which a few years ago served to split the ears of sensitive persons who were unfortunate enough to be passengers upon the Hudson River steamboats provided with them.

In 1470 pedals or keys, to be operated by the feet, were introduced by a German named Bernhard, and though numerous other improvements were made in the construction of the organ, by various builders of various nationalities, it was not until the next century that the organ assumed substantially its present form. Among the names of the sixteenth to the eighteenth centuries which became distinguished in the annals of organ building may be mentioned the families—for it was only by generations that the experience necessary for the perfection of the organ could be attained—of Antegnati of Brescia, Serassi of Bergamo, and Callido of Venice.

Under the Puritan domination in England, culminating in 1641, few of the organs in existence escaped destruction. The iconoclastic tendencies of the Roundheads found their gratification in smashing them as evidences of ungodliness; so that with the restoration it was found that the builders of organs had almost entirely disappeared from the country, and the aid of continental artists had to be depended upon for the re-establishment of the art.

This brief sketch of the early history of organ building could be greatly extended, did our space allow. For those, however, who are interested in pursuing the study further, we will refer, from the extensive literature in existence upon the subject, to the

following works: *L'art du facteur d'orgues*, by F. Bedos de Celles. The first edition of this work was published at Paris in 1766, and in 1778 another edition, in folio, illustrated with one hundred and thirty-seven plates appeared, which, though old in date, is yet well worthy of consultation by those interested in this specialty. In German the Abbé Vogler is one of the chief writers upon this subject. In Italian the *Lettere sugli organi*, by G. Serassi, published at Bergamo in 1816, is a work written by one practically acquainted with the subject. In English *The Organ, its History and Construction*, by Rimbault and Hopkins, published at London in 1856, is the chief work upon this subject.

In the United States, the progress made in the art of organ building reflects great credit upon those who have devoted themselves to it. The religious sentiments of the early settlers of New England were opposed to the use of musical instruments in church service. Yet organs were used in Massachusetts in 1714. The Episcopal Church in Salem had one made by John Clarke in 1743. The first organ built in the United States was constructed by Edward Bromfield, Jr., in Boston, in 1745. The first one used there was imported for the use of King's Chapel, and put up in 1714.

In 1752, Thomas Johnston built an organ for Christ Church in Boston. Yet, in 1771, the "lawfulness and advantages" of instrumental music in church worship were questioned in a publication issued that year in Boston, while in 1763 the same question had been discussed in a pamphlet printed in Philadelphia. A remnant of an organ, built by Johnston for the Episcopal Church in Salem, is still in the possession of the Messrs. Hook. It contains the name-board in front, upon which, in ivory, is carved, "*Thos. Johnston fecit. Boston, Nov. Anglorum*, 1754." Johnston died in 1768.

In Philadelphia, a new organ was ordered, in 1763, from Philip Feyring, who had previously built one for St. Peter's Church. It was finished and put up in 1766, and remained in use seventy years, until the present one replaced it. It contained three sets of keys and pedals, two octaves from foot C upward, twenty-seven stops, and about 1607 pipes. A few years later, an organ was built for the German Lutheran Church of Philadelphia, by Mr. D. Taneberger, a Moravian, at Litiz, in Lancaster County. The builder was a man who enjoyed a deserved reputation for his mechanical ability.

The first American organ builder was William M. Goodrich, who was born in Templeton, Mass., in 1777, went to Boston in 1799, and continued in the business until his death, in 1833. He gave a character to the art of organ building in this country, and rendered the importation of instruments from abroad unnecessary.

The progress we have made in the art is every way satisfactory and flattering. The mechanical construction of an organ is a trade which can be learned, like carpentering, cabinet-making, or any other mechanical operation. But this mechanical department is only a very small part of the art of organ building. It requires genius and skill to invent, devise, and plan the proper proportions and combinations of the various stops and pipes, with a capacity sufficient to so raise and tune them that the greatest musical effect possible may be produced by the instrument. To do this demands original genius and a cultivated taste, united with a knowledge and practical experience, together with a musical ear delicately sensible to the perfection of tone and tune.

Mr. Goodrich built his first church organ in Boston for Bishop Chevereux, of the Catholic church, in 1805. During the time that he continued actively engaged in business, from 1805 to 1833, only three church organs were imported into Boston, all the others used having been made in the country, notwithstanding the prejudice which still remained against the use of American organs.

Of these three organs, two were made by Friend, of London, and are said not to have been remarkable for excellence. The third was made by Elliot, of London, for the Old South Church. It was put up in 1822, and cost the society $7128.00. It is said that it was considered a superior instrument.

In 1807 Thomas Appleton entered into the employment of Goodrich, and continued with him for several years. When he set up for himself, he had a place in Milk Street, Boston, and afterwards was a member of the firm of Hayts Babcock and Appleton, which was dissolved in 1820.

The first three organs built by Appleton were voiced and tuned by Ebenezer Goodrich. One of them was afterwards revoiced and toned by Corri, an Englishman, who came over with the organ for the Old South Church, which has been mentioned.

Besides having a cultivated ear and a correct judgment concerning the vibrating qualities of wood, an organ builder should be acquainted both practically and theoretically with the art and sci-

ence of pneumatics. To arrive at perfection in this pursuit requires, therefore, as in every art, that the practitioner should be naturally endowed with the genius requisite for success, and that, by the subtile working of some natural law of selection, with which the students of the science of life are hardly yet sufficiently acquainted, he should unite in his own person an apparently intuitive comprehension of the results gained by the experience of those who have preceded him, together with an ability to originate for himself new methods of realizing the conceptions of his own mind.

In short, like all artists, he must be creative, and to reach forward, he must stand secure upon the foundation of the past. The study of the history of any art shows, that for its perfection the coöperation of generations is necessary. The advance made by one furnishes a stand-point from which that succeeding can start in its course of advance. By the experience and skill gained by one generation, the material is afforded from which individuals of the next can rise to a higher plane of artistic development. It is, therefore, evident that the pioneers in any branch of culture should be held in estimation, and that to them is due a portion of the credit which their successors obtain, since to them is due the merit of preparing the conditions for all subsequent advance, which without them would have been impossible.

In 1853 there were, in and about Boston, four extensive manufactories of organs — that of Appleton, at Reading; Stevens, at East Cambridge; and those of Simmons and Hook, in Boston. Mr. Appleton is still living at Reading, at the advanced age of eighty-two. The business of manufacturing church organs is still carried on in the city of Boston to considerable extent, as well as in other parts of the country. But the metropolitan character of New York draws to the latter city a higher class of artistic talent, in almost every branch of scientific manufacture, than is enjoyed by smaller cities, and the manufacture of church organs seems likely in time to be mainly, as it is now largely, carried on there.

COMBS.

EGYPTIAN, GREEK, AND ROMAN COMBS. — WOOD, IVORY, GOLD, AND SHELL AS MATERIAL. — COMBS FOR USE AND ORNAMENT. — TORTOISE SHELL. — WHERE AND HOW IT IS PROCURED. — CRUELTY OF THE PROCESS. — MANUFACTURE OF SHELL COMBS. — INLAID SHELL-WORK. — FIRST COMB MANUFACTORIES IN THE UNITED STATES. — EMPLOYMENT OF HORNSMITHS. — COMB-MAKING MACHINES. — EARLY PATENTS. — HOW COMB TEETH ARE CUT. — METAL AND MAGIC COMBS. — NEW MACHINERY. — VULCANIZED RUBBER COMBS. — IVORY COMBS. — PRINCIPAL PLACE OF MANUFACTURE.

Combs, both for use and ornament, are of very great antiquity. The Egyptians, Greeks, and Romans made their combs from hard wood, generally boxwood, and this material was used for ages, till horn, ivory, gold, and shell were substituted. The gold combs of the middle ages, worn as ornaments, or to support the hair, were frequently adorned with precious stones. The horny, overlapping plates of the hawk's-bill turtle were known to the ancient Romans, who used them in inlaying furniture and in ornamental work. This tortoise shell afterwards became an important article of commerce, especially in India and China, and the turtles are found also in the islands of the Pacific. Fifteen or sixteen pounds of shell plates can be taken from a single well-grown turtle, and the process pursued by the turtle-hunters is to remove the plates by heat from the back of the living turtle, then turning the turtle back to the sea again to grow another crop — a proceeding that may be considered a refined cruelty of commerce.

When the tortoise shell plates are to be manufactured into combs, they are softened by boiling, and are then cooled in metal moulds to any shape that may be desired. Excepting in Spain, Mexico, and South America, tortoise-shell combs, as ornaments, have nearly ceased to be articles of fashion, though a few years ago they were almost universally worn, and some of the more elaborately wrought patterns were very costly. The delicacy

of the filigree and lace-like work on some of the "back combs," required the skill of workmen who might be called artists. The cuttings of the shell were preserved, softened in hot water, and were moulded into plates for lesser-priced combs, and the shells of turtles, other than the imbricated, were used in making inferior articles. The use of other and cheaper materials for hair combs, for use and not ornament, has led to the employment of tortoise shell in inlaying cabinet ware, work-boxes, etc., and for making card-cases and other useful and ornamental articles.

From the days when a pair of wooden pocket-combs could be bought anywhere in the country for a cent, comb manufacture has been an important industry in the United States. Wood, horn, shell, metal, ivory, and, of late years, hard rubber, are the principal materials used in the manufacture. The colonists imported their combs from England; but in 1759 there was a horn-comb manufactory, the first in the country, at West Newbury, in Massachusetts, where the business is still extensively carried on. In the same year a comb-maker in Philadelphia advertised all kinds of combs at wholesale and retail. In 1774 the Provincial Congress of Massachusetts suggested the encouragement of "hornsmiths," who seem at that time to have made, not only combs, but shoehorns, powder-horns, and horn spoons. In 1793 there was a comb factory in Boston, and two or three factories in Leominster, Mass., one manufacturer making excellent ivory combs.

The first machine for making combs was patented by Isaac Tryon, of Connecticut, in 1798. As the importation of combs almost entirely ceased during the revolution, while the demand was not diminished, the domestic manufacture was important and profitable, and steadily increased. In 1809 three manufacturers in Connecticut obtained patents for making combs, one for wooden combs, and a New York manufacturer took out a patent for combs made from the hoofs of cattle.

At first the teeth in all combs were cut by a fine steel saw; but in 1814 one of the Leominster manufacturers secured a patent for a machine which would cut combs at one operation. Another patent for cutting and manufacturing was granted to a Philadelphia comb-maker in 1818. Two years afterwards was begun, in Saratoga County, N. Y., the manufacture of metal combs, in which the teeth were made of brass wire, and the new style soon became very popular. A more modern metal comb is made of lead, and is the "magic comb" which is supposed to turn gray hairs and whis-

kers to their "original color," as it does, if simply blackening them with lead can effect that miracle.

The importance of this manufacture has led to the introduction of new machines, which shape, press, size, cut teeth, and completely finish all kinds of combs with great rapidity and perfection. An ingenious machine cuts two combs at once from the same strip of ivory, shell, or other material, and for some kinds of combs the delicacy of the machinery is such that a hundred teeth may be cut in the space of an inch.

The invention of vulcanized India rubber, and experiments with hard rubber in various applications, resulted in the discovery that it is one of the best and cheapest materials for making combs, and very superior and highly finished rubber combs, which in flexibility and durability are equal to the best horn and shell, are now extensively manufactured. The principal factory for the making of ivory combs is located at Meriden, Ct., and the company was formed by the association of several leading manufacturers of that class of goods.

BUTTONS, AND THEIR MANUFACTURE.

BUTTONS OF NO USE TO THE SAVAGE. — CONNECTED WITH THE HISTORY OF COSTUME. — THE ROMAN USE OF THE TOGA. — MUSEUM OF BUTTONS; THEIR VALUE. — THE QUANTITY OF BUTTONS CONSUMED. — CLASSIFICATION OF BUTTONS.— THE PROCESS OF MANUFACTURE.— WHERE THE MATERIALS ARE OBTAINED. — ORIGIN OF THE NATIONAL BUTTON COMPANY.

From the naked savage to the civilized man of modern times, the gradations of clothing are infinite. Accustomed as we are to the style of dress we wear, it is seldom that it ever occurs to us men that the coats, the waistcoats and pantaloons we cover ourselves with, are not the natural and inevitable dress of men all over the world, and in all ages. Yet a simple inspection of such a work, for example, as *The Uncivilized Races of Men*,* will show that, even at the present day, it is only a small minority of the world's inhabitants who dress as we do, while perhaps nearly one half of the remainder look upon dress as a pure article of luxury, to be used more for purposes of personal decoration than from any considerations of decency or comfort.

In looking at the history of costume, and comparing the style of dress used by the ancients and the moderns, or, in the present time, by the nations of the East, and those of Europe and the United States, we shall find that the chief distinction which divides the subject of clothing into two classes is the difference of looseness. Among the ancients, as in the East to-day, the dress is flowing, and is worn as drapery, while among the civilized nations

* "The Uncivilized Races of Men in all Countries of the World; being a comprehensive Account of their Manners and Customs, and of their Physical, Social, Mental, Moral, and Religious Characteristics. By Rev. J. G. Woods. With numerous Illustrations. Hartford: J. B. Burr & Hyde. 1871. This is the best edition of this admirable exposition of the condition of the uncivilized races of men who are still existing in the world.

of to-day the various articles of dress are cut to fit closely to the person. In the East garments are wrapped round the person, while the civilized man puts his clothes on. The reason for this difference is really a question of buttons, and it is to the invention and introduction of this simple and useful article that we must ascribe the difference of our methods of dressing from those in use in the East, and, at the same time, the difference in our avocations and habits of living, which are so dependent upon the style of our dress.

The savage, who first fastened his robe, made of some animal's skin, with a thorn or a sinew, so that he could wear it and use his hands without the necessity of holding it on, commenced the advance in costume which with us has finally culminated in the coats and pantaloons of to-day. It might not be too much to say that the Romans retained the use of the toga chiefly because they had not yet discovered any inexpensive way of making buttons. Had they been able to fasten their garments by some simpler method than that of brooches or strings, the dress coat and the waistcoat would not have remained undiscovered until modern times.

During ancient times buttons were far from being as universally used as they are now. Clasps, hooks and eyes, various devices made of metal, and resembling in principle our breastpins, were the articles most generally used for fastening the two edges of garments, and with these and strings the people of those times had to be content. Now, however, buttons are made of various materials. Metals, glass, porcelain, horn, bone, india rubber, mother of pearl, wood, are but a small part of the substances which have been impressed into this service.

In some of the museums of Europe are collections of buttons; and insignificant as such a collection might seem, yet, when thus brought together and classified, they form the material for a study of our social history which is by no means to be despised. One of the most curious kind of button was in use about a century ago among the aristocratic fops of England. They were made of polished brass, and, being ruled with lines so fine as to be almost microscopic, the roughness of the surface thus obtained served to break the reflection of the light falling upon them, and gave them, apparently, the prismatic colors. The peculiar beauty of mother of pearl, and its iridescent brilliancy, are said to be produced by the fact that the thin plates overlap each other

unevenly, and thus disperse the light as they reflect it. These buttons appeared thus iridescent from the same cause, and, being very expensive, costing a guinea each, they were, of course, for a time the rage.

The quantities of buttons consumed is enormous. Some impracticable economist has calculated that if the civilized world at large could be induced to forego the wearing of the two buttons upon the backs of our coats, where they are of no practical use, and of doubtful decorative value, the amount thus saved would, in time, accumulate to sufficient to support an extended system of charity. Fashion, however, which regulates according to its own fancy most of these things, has recently tended towards the discarding of these supernumerary buttons; but, as far as known, the money thus saved is not wholly applied to charitable purposes.

Buttons are of two kinds, those which are to be sewed to the garment through holes drilled in the button itself, and those which have a shank by which they are attached to the garment. These last are most generally made of metal, and the process of making and covering them can be best shown by a description of the works of the National Button Company, at East Hampton, Massachusetts, where the various operations have been systematically organized.

The iron used for the shell of the buttons is of the best quality, and is delivered in sheets, and is first "scaled," the scales being removed by acid, in order to preserve the tools. The iron is then submitted to a machine which cuts it into the required shape and size. The collet, or under portion of the button, and the shell, constitute all the iron used in the button. The collet, after being cut and stamped, is then japanned. The filling of the button is made of brown paper or of button board. The covering and the shank of the buttons are cut by hand, with hollow chisels.

The next process is putting the parts together, or, as it is technically called, covering them, which connects all the parts. Next the buttons are subjected to the process of pressing, which gives both strength and the required shape to them. Then they are inspected, and all that are not perfect are rejected. Then they are counted out by weight; a gross having been counted are weighed, and this weight serves as a measure for counting out the rest. Next they are packed, ready for shipment.

The extent of the business can be estimated from the following

statistics. The amount of iron consumed by the National Button Company varies from five hundred to seven hundred boxes a year; each box containing from one hundred and twelve to one hundred and twenty pounds of iron in sheets. The coverings for the buttons consist of various materials; the lasting, brocade, and twists are mainly imported, as is also the canvas for the shanks.

For this industry the world is laid under contribution, a portion of this material coming from England, while the brocades and twists are imported chiefly from France and Germany. The production of this establishment amounts to four hundred and fifty thousand gross a year, or almost sixty-five millions of buttons, which it would seem was enough to supply the needs of the entire population of the country, whether the supernumerary buttons worn on the backs of coats were discarded or not.

In the production of these one hundred and forty persons are employed, who are mainly adult women, and Americans by birth. The business was commenced by Joel Hayden, of Haydenville, who, in 1834, began to make flexible buttons. Before the present process was introduced the buttons were covered by hand, and the covering secured by sewing; but this slow process had to be discarded, in order to meet the growing demand, and, by the gradual introduction of their new methods, the company has eventually reached their present position among the leaders in this branch of national industry.

HOTELS.

OLD ENGLISH INNS. — AMERICAN TAVERNS IN THE STAGE-COACH DAYS. — LANDLORDS AND SERVANTS. — THE HOTELS OF TO-DAY. — EXTRAVAGANCE AND DISPLAY VS. ECONOMY AND COMFORT. — THE TABLE D'HOTE SYSTEM. — HOTELS IN EUROPE ON THE AMERICAN MODEL. — THE LOUVRE AND GRAND HOTELS IN PARIS. — THE LANGHAM AND CHARING CROSS HOTELS IN LONDON. — D. D. HOWARD'S PROJECT. — THE EUROPEAN PLAN IN THE UNITED STATES. — THE PIONEER ESTABLISHMENTS IN AMERICA. — REVOLUTION IN HOTEL KEEPING. — LANDMARKS OF AMERICAN PROGRESS. — MARCH OF NEW YORK UP TOWN. — MANIA FOR IMMENSE HOTELS. — GREAT SEA-SIDE AND WATERING-PLACE ESTABLISHMENTS. — ACCOMPANYING INDUSTRIES. — FAMILY HOTELS. — THE MODEL MODERN HOTEL. — EVERYTHING UNDER ONE ROOF. — LABOR-SAVING MACHINERY. — SHOPS AND STORES. — A COMPLETE CITY IN MINIATURE. — THE NEXT LESSON TO BE LEARNED.

FALSTAFF'S question, "Shall I not take mine ease in mine inn?" is an expression of that complete comfort and entire independence which travellers in all ages and in all nations have at least expected to find in a public house; but often indeed has the ancient legend, "Good entertainment for man and beast," been only a promise to the eye, as well as ear, to be broken to the hope. The hostel of old times became the inn; with the increase of travel and the growth of cities, the inn expanded to the hotel — a name hitherto applied to the great and sumptuous city residences of the noble and rich in Europe; and with the present and prospective advance in the size and splendor of hotels, particularly in the United States, we shall soon come to express their full grandeur by calling them palaces, as indeed some of them are.

Before the days of railways in England, in the old mail-coach times, the wayside inns were the embodiment of good cheer and comfort. And so in the stage and turnpike times in the United States, the tavern in country towns and in cities gave the sojourner, at reasonable rates, the real worth of his money in food, drink, and lodging. Then the huge clapboard or staring red brick

"hotel" close to every railroad station, with its profusion of often ill-cooked meats, its adulterated liquors, its horde of ill-trained, sometimes ill-mannered, Hibernian "help," its small, unventilated rooms, its economy of actual comforts, and its extravagance of supposititious charges in the bill, was unknown. The cleanly, unpretending "tavern," with its table bountifully furnished with the best products of the field and garden, wood and river, and attended by neat handmaids, exists now in rare instances, or in remote places removed from the great lines of travel. When such resorts were common, the landlord was not, as now, the traveller's master, but his servant; and the "guest," as the sojourner is even now called, was indeed a guest, and during his stay was so considered and treated.

Extravagance and display have almost entirely superseded the old-fashioned economy and comfort. This is simply because the change has been demanded. The present generation likes large hotels, and the correspondingly large hotel bills, which imply the desire for unbounded luxuries and the ability to pay for them. Americans, too, more than any other people, are gregarious; and if a man is known by the company he keeps, Americans especially are known by the amount of company they keep, and hence, with perpetual travel and much hotel frequenting, they have and make more acquaintances than any other people in the world. The *table d'hote* which assembles from one hundred to one thousand persons in a single dining-room, with the accompanying din, as well as dinner, the clatter of cutlery and crockery, and the rush of a regiment of waiters, is an Americanism which is not, nor for some years is likely to be, popular abroad, though it obtains to a limited extent in some of the more modern German hotels, and in some of the English and European watering-places. Nowhere else in the world is the hotel so essentially a "public" house as in the United States; and publicity in its fullest extent in the halls, parlors, reading-rooms, and dining-rooms is here preferred to the comparative privacy which is sought in hotels abroad.

The great modern hotel, wherever it appears, abroad or at home, is a strictly American invention. When the Hotel Louvre, in Paris, — the first of the immense foreign hotels, — was projected, complete plans of the then recently-erected St. Nicholas Hotel, in New York, were sent over to give the Parisian architect an idea of the interior arrangements. The Grand Hotel, of Paris, yet more extensive than the Louvre, is only a more complete carrying out of

the American plan of a first-class city hotel. But to the American idea of a hotel building was wedded the European idea of hotel keeping, which is only beginning to make its way in the United States — that is, of charging guests according to their actual accommodations, and of not compelling a guest who occupies a room just under the roof to pay the same price charged to a more favored customer, to whom is assigned a better and far better furnished apartment on the first floor. What is called, too, the "European plan" — meaning often a plan on which no hotel in Europe is kept — that is, of furnishing meals from a bill of fare at a certain price for every dish, thus implying that the guest pays only for what he orders — obtains now in some American hotels, in many, even, which still maintain also a *table d'hote*, and which charge such guests as choose a fixed price per day for all that the hotel can furnish.

Thus we have borrowed a little from countries to which we have given much. Till quite recently, London and Paris, which assemble constantly crowds of travellers from all nations, had no large hotels; or rather, a hotel which could feed and shelter a hundred guests was deemed a large one. A few years ago, D. D. Howard, who had attained celebrity and acquired a fortune as a hotel keeper in New York, contemplated the erection of an immense hotel on the American plan in London. The difficulty of securing a proper location and the cost of land dissuaded him from his project; but since then the Langham Hotel, kept by an American, and the still larger Charing Cross Hotel, have furnished suitable and much-needed accommodation for travellers, and have given Londoners an idea of what a hotel really is, or should be.

Among the now numerous hotels in the United States, the St. Charles, at New Orleans, and the Astor House, in New York, were the pioneer establishments. These establishments were, in fact, experiments — to see if the assemblage of the accommodations of several hotels under one roof, with the consequent economy in management, might not result in a complete revolution in the system of hotel keeping. It did. The experiment, from the start, was a success. The world-wide reputation which these hotels achieved for their vastness, their tables, their conveniences, their comforts, with the immense increase of travel which ocean steamers and railway lines induced, soon necessitated the erection of similar but larger and more complete hotels in every leading city in the Union.

These great hotels are great landmarks of American progress in wealth and population. In New York, milestones bearing the date of the opening of new streets would not more surely mark the growth of the city in business and boundaries, than do the great hotels in their march towards Harlem. Time was, within the memory of men yet in their prime, when the Astor and Irving (on the corner of Chambers Street and Broadway) were "up town." When the St. Nicholas and Metropolitan Hotels were projected, it was predicted that they were too far away from the business and travel centres to "make a living;" no one would go "so far up town;" it was folly to build them: but now these up-town hotels are very far down town; and above them on Broadway, on Union and Madison Squares, on some of the cross streets, up to Forty-second Street, have since been erected even larger and finer hotels, while the most expensive and enormous establishment yet projected is to cover a whole block in front of Central Park. The locations of these new hotels indicate the up-town progress of business; and with the hotels the theatres, which are mainly supported by the floating population, go also; and with these also the retail stores, particularly those devoted to dry goods, jewelry, and articles of luxury, keep pace. The building of the new grand railway station at Forty-second Street will compel the erection of large, first-class hotels in that vicinty.

The mania for immense hotels has extended from New York, not only to other cities, but to the smaller sea-side resorts and watering-places. Newport, Long Branch, Cape May, Saratoga, and the numerous new resorts on Long Island Sound, and along the Atlantic coast, now exhibit hotels which often surpass in size the largest establishments in the cities. When it is considered that the entire season for most of these hotels covers a period of only three months, in which the whole harvest of the year must be gathered, it may be imagined how many thousand guests are to be accommodated, and proportionally "charged," to pay the expenses of these houses, and to leave besides the oftentimes enormous clear profit for the owners and proprietors. These hotels are also the direct stimulus to other industries and business, such as the shops kept open only in the summer, billiard-rooms, livery stables, etc.; and they occasion a vast amount of expenditure on the railway and steamboat lines of travel.

In some of the large cities, in New York especially, the high cost of living, covering rent, servants' wages, food, fuel, and all

that housekeeping compels, has induced many families to live permanently in hotels, where more luxury can be secured at less expense than in any other way. There are now many strictly "family hotels," comprising the best features of the "community" system, in which each family really shares its proportion of the expense in the management and attendance of a large establishment. Quite lately, hotels on the foreign plan have been built in New York, where unfurnished suits of rooms are let to individuals and families, in which all the privacy of a house is secured, with the advantages of a public restaurant, or meals in one's own rooms, the laundry, the services of superior servants, and all the multitudinous comforts and conveniences which a great hotel can give. When the economy of this kind of living, as compared with the expense necessary to secure half these conveniences and accommodations in a private establishment, is considered, the family hotel, on the latest plan, will be as popular in America as it is abroad.

The model modern establishment in American cities is something more than a mere hotel. It combines under one roof many separate industries, nearly all conducted with the greatest economy, on the most improved plans. The kitchen and laundry are supplied with labor-saving machinery. Steam-propelled elevators hoist and lower guests and their baggage from one floor to another. There is an effective police and fire department. A post-office is an essential feature. There is telegraphic communication, not only with all parts of the hotel, but with every quarter of the world which is reached by the wires. Under the same roof, and connecting by entrances with the hotel, are retail stores devoted to the sale of clothing, shoes, hats, jewelry, trunks, travelling-bags, and other needed articles. Billiard-rooms and bath-rooms adjoin, and from the Metropolitan Hotel, in New York, one can step under cover into Niblo's Theatre. In short, the first-class American hotel is a complete miniature city, in which the guest can find everything essential to his comfort, and everything to his satisfaction, perhaps, excepting the bill. And the bills will be smaller when American landlords learn how to apply the economy, so conspicuous in most departments of their business, to the lessening of the woeful waste which now appears in their kitchens and dining-rooms.

HYDRAULIC WATER POWER.

MAN'S FIRST CONCEPTION OF THE FORCES OF NATURE. — THE FIRST AIDS HE USED. — THE FIRST PROPOSAL TO BUILD A DAM. — THE SPANISH CORTEZ AND THE DUTCH. — STEAM AS A POWER. — WIND. — THE SUNLIGHT. — AN ESTIMATE OF THE POSSIBLE WATER POWER. — MODERN SOCIETY FOUNDED ON INDUSTRY. — THE COMMENCEMENT OF THIS CENTURY IN NEW ENGLAND. — THE CONNECTICUT. — THE HADLEY FALLS COMPANY. — THE LOSS OF THE FIRST DAM. — THE SECOND DAM BUILT. — THE HOLYOKE WATER POWER COMPANY. — ITS SUCCESS. — THE DAM STRENGTHENED. — THE HISTORY OF HOLYOKE.

In the early history of the human race men were naturally impressed with the stupendous energy of the natural forces of nature, as compared with the energy of their own muscular strength. It is no wonder, then, that, cowering helpless before the whirlwind, or drenched with a driving storm, or blasted with a lightning stroke, our forefathers of those days naturally considered these exhibitions of the energy of nature as evidences of the might of some wrathful being of a greater power than their own, whose anger was to be feared, and whose passion to be appeased, if possible, by submission and adoration. Between these destructive manifestations of the energy of natural forces, and the beneficence of the orderly progress of the seasons, of the warm sunshine and the gentle showers, making the earth blossom with herbs and flowers, and ripening the grains and fruits for the sustenance of men, it seemed impossible to see any connection, or to consider them as simply different manifestations of the same cause.

So, too, it must have been a long time before men found that the energy of the natural forces could be made subservient to their own needs. At first man must have depended entirely upon his own muscles for the force he required to exercise in performing any work. The next step was impressing animals to his

service. But this is depending upon the most complex organizations in the world for the supply of what nature provides gratis. Doubtless, to the "practical" men among his contemporaries, the man who first proposed to use the energy of a brook which ran babbling over the rocks, as it fell in its course from some higher to a lower level, was considered an impracticable theorizer, or, perhaps, a daring innovator, who would irreligiously propose to alter the established order of things. Though this may appear impossible to us to-day, when the steam engine and the telegraph are in such common use, yet instances of the same spirit displayed in quite modern times show us that it is quite probable that such was the reception of the first suggestion to utilize the energy of a waterfall.

During the reign of Philip II., of Spain, who died in 1598, an offer was made by the Dutch to deepen the Tagus and render it navigable. The proposition was submitted to the Cortez, who replied to it that had Providence intended to make the Tagus navigable, it would have created it so, and that they declined the proposal, since, in their opinion, attempting such a thing would be contrary to the decrees of Providence.

Though, in the present age of the world, our industrial advance is not restrained or hampered by such considerations, yet the spirit which dictated this reply is not yet entirely dead, but, in other departments of human thought and energy, would limit and repress the increasing power of the human mind by a similar acquiescence in ignorant beliefs.

Of all the modern sources of power upon which the wonderful industrial advance of the present century is founded, that derived from water-courses is the cheapest. To utilize the energy of steam requires a complicated and expensive arrangement of machinery and a constant supply of fuel. The motive force of the wind, as applied in wind-mills, is liable to such fluctuations that it cannot be counted on with such certainty as an established industry requires. In Holland, however, where the flatness of the country offers little or no opportunity for the use of water power, wind-mills are largely used. The landscape is dotted with them, and the chief work of the country is performed by them. Quite recently the suggestion has been made for collecting and using the power of sunlight for obtaining a motive power. There is no doubt that appliances could be made by which this could be

successfully done; but as yet no practical steps have been taken to perform it.

Steam is, however, the chief source from which the industry of modern times derives its motive power. The reasons of this are chiefly that the steam engine can be introduced anywhere, while water power can be obtained only in certain localities. Again, too, the work necessary to be done before obtaining the control of a stream, the dams to be built, the canals to be dug, and the other various work to be performed before the energy of a waterfall can be practically applied, necessitate so large an expenditure of capital that some of our best natural opportunities for using the largest streams are still neglected. It is probably a fair estimate that only a small part, perhaps not a hundredth, of the water power of this country is as yet utilized. Even in the oldest settled parts of the country the utilization of the streams has heretofore been, as a rule, intrusted to individual enterprise. The conception of a thorough and complete survey of the whole country, with the view of utilizing the entire water power which its natural configuration affords, by an extended and well-organized system, has not yet been entertained. In this respect, as with our railroads and other industrial enterprises, the tendency of the times is towards the conception and realization of projects which would even in the last generation have been considered impossible, while, at the same time, it is daily becoming more evident that the method with which such enterprises are pursued must be such as shall serve the purposes of the increasing tendency of society towards a plan of more intimate union and interdependence of its parts.

Our modern society is founded upon industry, instead of war. In Rome and in Greece all industry which was carried on was performed by slaves, who were kept in a state of degradation and poverty which was, perhaps, worse even than that existing in this country before the abolition of slavery. The business of the state was warfare, and to this alone the increase of the national wealth was owing. The tribute of the conquered nations was the only resource depended upon for the immense sums of money which supported the extravagance of the wealthy classes, and the ambitious men of that time planned a new campaign, instead of, as at present, establishing some new branch of industry.

In the modern world, therefore, the utilization of the energy Nature displays in the action of her natural forces, is really the

foundation of our social organization; and he who proposes new methods for doing this, and introduces them into practical operation, is entitled to public consideration. In the early part of this century, when manufacturing industry began to interest the attention of the capitalists of New England, the undeveloped water power, then running simply to waste, was studied carefully. In Lowell, Manchester, and various other towns of New England, which fifty years ago were simply farms, we see the results of the combined effort necessary to utilize the energy of the streams which formerly ran uselessly away. Now cities, with varied industries, support large populations, where formerly a few cattle cropped a scanty herbage, or the farmer, by hard labor, gathered his meagre harvest.

The chief river of New England, however, the Connecticut, was at first thought to be too large a stream for human labor to master and turn to its own uses. But industry, like ambition, grows by what it feeds on, and, as the man performs easily tasks which to the child seem impossible, the Holyoke Water Power Company have performed the task which to the last generation would have seemed absurd to attempt.

As late as 1831 the present site of this vast water power was a rocky channel, through which the Connecticut ran away to waste over what was known as the great rapids, or falls of South Hadley. These falls were situated at a point between the lower village of South Hadley, on the easterly side of the river, and a sparsely settled agricultural district, known as Ireland Parish, which was then a part of the town of West Springfield, on the west side of the river. The rapids extended for the distance of a mile and a half, with a total fall of sixty feet.

In 1831 a company was formed, under the title of the Hadley Falls Company, for the purpose of utilizing a portion of the power, by the erection of a wing dam on either side of the stream, which should divert a portion of the water of the river, and make it thus available for industrial purposes by means of canals. By this means a small paper mill on the east side of the river, and a cotton mill, capable of running about two thousand spindles, were provided with power. This was the only use made of this enormous water power until the year 1847, when a charter was obtained for a company, bearing the same name, but with a capital of four millions of dollars, for the purpose of damming the entire stream, which at this point is one thousand and nineteen

feet wide, and, by a system of canals upon the western side, making use of the whole of the water power. Operations were immediately begun, and the dam was finished on the 19th of November, 1848.

Crowds of people, whose interest in the structure had been excited during the year this gigantic work was going on, clustered upon the banks to see the water gather after the gates were closed. During the month before, a great freshet had swept down the river, and it was known that the dam had sustained some injuries, though it was hoped these were not too serious. As the waters gathered, a trench was made in about the middle of the dam, into which large stones were thrust, with other material, in the hopes of preserving the structure, which had been reared with so great an expenditure of time and money. At one time, so great was the pressure of the water, that it was feared the abutments themselves would give way, and the lower part of the town be flooded.

These, however, stood the strain, and the water rose steadily until, at about two in the afternoon, it had nearly reached the top of the dam, when with a mighty crash the whole structure gave way, and the immense volume of water rushed through its accustomed channel, bearing with it the ruins of the too feeble barrier which had been erected to stay its course.

Disastrous as was this result of a year's labor and expense, yet the company was not dismayed at their failure. With admirable persistence they commenced immediately to rebuild their dam on an improved pattern. The construction of this second dam occupied not quite a year, it being finished on the 22d of October, 1849, and it has since stood the immense pressure of the whole body of Connecticut River, even when swollen by the spring freshets.

The success of the dam was all that was wanting to insure the immediate settlement of the banks of the river as a manufacturing centre, and shops and mills were soon built along the line of the canal, which was thus furnished with the water that before had fallen uselessly over the "rapids." The power which is thus made available is distributed by means of three canals, at different levels, and furnishes, in the aggregate, about eight miles of available sites for mills. This improvement has thus rendered practicable a power equal to that used in Lowell and Manchester combined,

and greater than that furnished by any similar structure in the world.

The estimate made of the water passing through the channel at low-water mark in 1847, and based upon an accurate measure, was found to be six thousand cubic feet a second, which, converted into power, gives a total of thirty thousand horse power. Allowing a deduction from this total of one third, for the variableness of the seasons, and friction or other causes, this leaves a total of twenty thousand horse power, which is equal to three hundred mill powers. Of this power about one third is now employed.

The total loss of the first dam and the expense of building the second one involved the company in financial embarrassments, which were further increased by the business crisis of 1857, and under this pressure they were forced to suspend.

A new company was formed, with the title of the Holyoke Water Power Company, which purchased the property, with the improvements, for $350,000. In 1868 the dam, which had stood twenty years, was examined carefully, and it was found that it required repairing. The unusually heavy freshet of this year had awakened apprehensions of the strength of the dam, and the examination showed that the concussion of the heavy masses of ice brought down by the spring floods had loosened and worn away many of the front timbers of the dam, and also that the rock foundation of the dam was being undermined.

As at first built, the dam presented a sheer front on the side down stream, and the volume of water pouring over this had gone far towards undermining the foundation. The bed of the river at this point is of rock, but is full of seams, and the enormous force of the falling water had lifted out the rock in masses, scattering them, from a ton to twenty tons in weight, for a considerable distance down the stream. The result of this had been to make a great hole in front of the dam, from twenty-six to thirty feet deep, and extending along the entire front of the structure. To remedy this, the dam was thickened and strengthened by a new front, which slopes gradually, thus presenting an inclined plane for the flow of the water when the stream is so swollen as to flow over the top, and delivering it so easily as not to render the new structure liable to the same process of undermining.

This strengthening of the dam was finished at an expense of about $400,000, and insures its permanence. The original com-

pany had found, at first, considerable difficulty in obtaining possession of the land necessary in order to control the water power, and it was only after months of negotiation that they were able to overcome the prejudices of the chief owner against selling his property to a corporation. They were, however, finally successful, and the property now owned by the Holyoke Water Power Company, which entered on their rights, comprises about one thousand acres, intersected with three miles and a half of canals, arranged upon three levels. These canals and the necessary streets occupy about one half of the company's property.

The town of Holyoke, which is the legitimate offspring of this great work for this utilization of the hydraulic energy of the Connecticut River, was incorporated in 1850, and now contains an industrious and thriving population of over eleven thousand persons, who have, in a little more than twenty years, settled upon what was before a sterile pasture. In this way a comparatively barren spot has been changed into a thriving and enterprising town, which ranks third in the list of the manufacturing centres of Massachusetts.

FISH CULTURE.

FORMER ABUNDANCE OF FISH. — PRESENT SCARCITY. — HOW THE RIVERS HAVE BEEN DEPLETED. — MEANS FOR RE-STOCKING. — ANCIENT PISCICULTURE. — THE CHINESE AND ROMANS. — A LOST ART. — ITS RE-DISCOVERY. — PINCHON, OF FRANCE. — JACOBI, OF HANOVER. — EUROPEAN EXPERIMENTS AND ESTABLISHMENTS. — REMY AND GEHIN. — THIRD RE-DISCOVERY OF ARTIFICIAL BREEDING. — THE FRENCH GOVERNMENT IN THE BUSINESS. — LOUIS NAPOLEON INTERESTED. — THE GREAT FISH FARM AT HUNINGUE. — IMMENSE DISTRIBUTION OF OVA. — GERMAN, SWISS, SCOTCH, IRISH, AND ENGLISH ESTABLISHMENTS. — SALMON LADDERS. — THE PROCESS OF BREEDING TROUT AND SALMON. — NATURAL SPAWNING. — METHOD OF THE FISH FARMER. — ESSENTIALS FOR AN ESTABLISHMENT. — FORCED SPAWNING AND IMPREGNATION. — TIME REQUIRED FOR HATCHING. — CARE OF THE YOUNG FISH. — INCREASE IN SIZE FROM YEAR TO YEAR. — HOW FISH ARE FED. — BREEDING BASS AND OTHER FISH. — RAISING SHAD. — WONDERFUL FECUNDITY OF FISH. — PRACTICABILITY OF FISH FARMING. — PROFITS OF PISCICULTURE. — ANECDOTE ABOUT AN AMATEUR ANGLER. — STATE LEGISLATION FOR FISH CULTURE. — FISH COMMISSIONERS. — PROGRESS OF PISCICULTURE IN THE UNITED STATES. — PROSPECTS AND PROPHECIES.

IT is traditional that, years ago, when a man bought a shad at any of the fishing places on the Connecticut, so much more plentiful were salmon in the river that, with every shad sold, a salmon was "thrown in." It is on record that there was a time in Connecticut when masters were restrained by law from compelling their apprentices to eat salmon or trout more than three times a week. In Europe, too, in times past, fish of all kinds have been so common that similar stipulations have been made that this food should be served to domestics only at stated intervals or on fast days. Until a comparatively recent period the rivers of Europe and of the United States, particularly the Northern and Eastern States, fairly swarmed with salmon, and the brooks and streams everywhere were alive with trout. This food, at once wholesome, appetizing, and cheap, was within the reach of the poorest; but now, what was one once of the commonest and most easily attainable necessities of the poor has become an expensive luxury for

the well to do and rich; salmon and trout are the most costly fish in market, and shad are smaller, scarcer, and higher priced from year to year.

What has become of the fish — particularly the salmon and the trout? Why have salmon, once so cheap and plentiful, deserted the rivers of New England and the north? The only sources of supply for years have been the Kennebec River, in Maine, the rivers of the British provinces, and quite recently those of California; and fish brought on ice from remote regions, with impaired flavor and enhanced price, commands in the eastern markets from twenty cents to two dollars a pound, according to the season and supply. Undoubtedly the industries of the country are mainly responsible for driving away the salmon. A few years ago the beautifully clear waters of the Merrimac River, running from New Hampshire through Massachusetts and the Atlantic Ocean, were filled with salmon of from nine to twelve pounds in weight; but on that river, as on other rivers, the dams and factories, and the discharges from mills, tan-yards, sewers, and dye-houses have forced the fish to seek purer streams. Cities, too, with their sewerage and poisonous outpourings from gas-houses, are fatal to salmon, though the shad seem to survive these evils long enough to reach their spawning grounds and return to the sea. Happily, however, means are now in operation which will go far to remedy some of these evils, and to re-stock long deserted rivers with the fish that once made these rivers their favorite resorts.

Obviously, the first means to attain the desired end is to supply "ladders," which is effectually done so that shad and salmon can ascend the dams; and next, to prevent, or limit the erection on fish-bearing streams of print-works, dye-houses, gas-works, paper-mills, or other establishments whose discharges may poison the water. But best of all is the process of supplying perfectly clear and unobjectionable lakes, ponds, and streams with stocks of such fish as salmon, bass, trout, shad, etc., which is now effected to such an extent that, in a few years, the choicest varieties of fish will be among the cheapest as well as most desirable meats in our markets. This is done by what is variously called fish-culture, fish-farming, and artificial fish-breeding.

Ancient Fish-Culture.

Modern fish-culture is the recovery, or re-discovery, of a long lost art. The Chinese, who claim the origination ages ago of

every discovery — who have known silk-culture, printing, engraving, gunpowder, and many other things for centuries — understood at a very ancient period the process, not only of preserving, but of artificially breeding in the remote and interior regions of their vast empire the fish so necessary to the support of an enormous population living almost entirely upon fish and rice. The ancient Romans, if they did not know how to breed fish, certainly understood the art of preserving them — that is, of protecting the spawn and young fish from the ravages of the older fish, reptiles, rats, and birds, which feed upon them, and of bringing the fish to maturity for the table or for breeding. It is a question whether the Chinese or the Romans understood the process of fecundating the ova; but if they only carefully collected, preserved, and hatched the impregnated ova, which they did with entire success, they well knew what is really the most important part of fish-culture. For when it is considered that of the thousands of eggs from single fish of the trout and shad kind, as naturally spawned, only a very small portion comes to maturity, while the great bulk is devoured or washed away; and of what is hatched, that the young fish, especially salmon and trout, have numerous enemies, including their unnatural progenitors, which devour them by thousands — it is indeed a valuable discovery which insures the hatching of from ninety to ninety-five per cent. of the entire number of eggs by artificial means, and by measures which insure the safety of the ova and the young. The Chinese and Romans also made the important discovery that fish readily adapt themselves to new localities; that they may be introduced in entirely new waters; that salt-water fish may be bred and brought to perfection in fresh water; that the ova, properly packed, may be transported to great distances; and other vital matters pertaining to successful fish-culture in our own day. Thus, at present, deserted streams are not only re-stocked with ova from remote rivers, but fish of different kinds are introduced in sections where they never bred naturally; pickerel have been put into ponds in Western Massachusetts; pike from the northern lakes have been brought to Connecticut; and it is confidently expected that choice foreign fish like the turbot, the Danube salmon (which has been *bred* in Europe to its full weight of two hundred pounds), and other varieties soon will be imported and reared in the United States. But what was known to the Romans was lost to Europe, and for centuries the Chinese, who cut themselves off from communication with the rest of the

world, kept to themselves the secrets of the art of successful fish-farming.

Recovery of the Art.

There are many claimants to the honor of the re-discovery of the art. It was practised in France in the fourteenth century All works on Pisciculture give credit to Pinchon, a monk of Réome, for "inventing" a mode of hatching fish, similar to the modern process, but the art of artificially impregnating eggs was lost with his death. His works, important as they were, literally followed him, and it was not until the eighteenth century that the art, twice lost, was once more re-discovered. Jacobi, of Hanover, after years of experiment, made public, in 1763, his plan for fish-breeding — the same in principle as that now pursued. His fish farm, established with assistance from the government, was soon able, not only to supply the home market, but to export large quantities of fish to England and France.

Experiments and Establishments abroad.

Experiments began in the salmon streams of Scotland in 1833, and in 1837 a few fish were artificially hatched, and were reared to the age of two years. But for what is known now of practical and profitable pisciculture, Europe and America are indebted to two French fishermen, Remy and Gehin, living near the head waters of the Moselle. They saw and deplored the constant diminution of the trout for which they fished, and which furnished their support. Pecuniary interest led them to watch, as they did carefully for three years, the manner of natural fecundation. Their first idea was to devise means to prevent the destruction of the ova and young fish, and their investigations in this direction led to the discovery, for the third time, of the process of artificial impregnation.

Their experiments, as early as 1842, resulted in the stocking, or re-stocking of several rivers. Five years later their enterprise and its success was known to the French government. It was shown that the fish-farm of these men had re-stocked the Moselle with salmon, trout, and other fish, and that their establishment was bountifully supplied with ova and young fish ready for transfer to other streams. All Europe became interested in the subject. Jean Jacques Coste, of the French Academy, after personal investigation, suggested the undertaking of a great government estab-

lishment; Louis Napoleon, then President of the French Republic, was willing to risk thirty thousand francs in the experiment; and the result was the soon celebrated fish-farm at Huningue, on the Rhine. With a further appropriation of two hundred thousand francs, in all say fifty-six thousand dollars, it became the finest establishment of the kind in Europe. It furnished eggs and fish for the rivers of France free of cost, and further supplies, provided returns were made of the success of the first operation — besides selling to other countries and individuals sufficient quantities to make the establishment entirely self-supporting.

Within ten years of its establishment the Huningue farm furnished in 1861 to France and to eleven other countries nearly seventeen millions of eggs. Before the days of Remy the French fisheries were well nigh exhausted. Huningue made fish more plentiful than ever. It stimulated the forming of similar farms all over Europe. It demonstrated that a fish crop may be raised with far more certainty than any grain crop, because it is entirely exempt from casualties by drought, insects, hail, and other evils, since with proper care nearly every egg can be hatched. Huningue has had enough confidence in this crop to send out for planting in the past few years an annual average of twenty million fish eggs. Elsewhere in France there are eel-breeding establishments, and when it is stated that a pound weight of eel fry, say eighteen hundred young eels, will increase within two years to a weight of four tons, it will be seen that an enormous amount of nutritious food is furnished at a small cost.

Following France and the methods practised at Huningue, Germany and Switzerland have been prominent in pisciculture. The Galloway ponds in Scotland, and the Galway establishments in Ireland, supplied with salmon eggs from Scotland, are eminently prosperous, and fish-farming is pursued with entire success in England and in Wales. It was early shown in Great Britain that dams are not necessarily an obstruction to fish ascending rivers to spawn. The remedy is to leave openings in the dam, with cross-pieces to prevent too great a loss of water, and through these holes the salmon find their way. Salmon ladders, on the same principle, extend down from the top of the dam, the cross pieces enabling the fish to rest while making the ascent, and swarms of fish may be seen making their way in the spawning season up these ladders. Everywhere abroad, too, proper laws have been made to protect fish when they are running up rivers to spawn.

The Mode of Artificial Breeding.

The methods of pisciculture are the same in all properly conducted establishments in Europe and in the United States. The purpose of the pisciculturist is to imitate and assist Nature In natural spawning — to take, for instance, the trout as a representative of the salmon family, to which it belongs — in the spawning season, which is in October and November, the female ascends the stream, digs down into the gravel, and deposits her eggs. The male goes over the eggs to "milt" or impregnate them, and the milt and spawn are deposited at the same time. The female then returns and covers the eggs with gravel, and they are left to become the prey of other fish, fowl, or reptiles, or perchance to hatch. The fish-farmer simply secures the eggs; sees that they are impregnated; watches their hatching; protects the young fish from their natural enemies and unnatural fathers; feeds them, and brings them to maturity. This is all; there is nothing elaborate or intricate in the operation. The more important part of the business generally is to provide impregnated ova and young fish for transportation to re-stock rivers and to supply the numerous private ponds and small establishments which now abound nearly everywhere in this country and in Europe, and to raise sufficient fish for further breeding.

The essentials for a fish-farm are clear spring water, ponds for fish of different ages, and a hatching-house usually forty feet by twenty-eight. The necessary implements are a bucket, tin pans, a ladle, a small net, a syringe for feeding, nippers, and a syphon to remove dead ova. A stove to warm the house, and troughs divided into boxes for the more convenient distribution of the eggs (and when the eggs are hatched, the young fish), complete the establishment. When the breeding fish are "ripe," that is, ready to spawn, the fish-farmer partly fills a tin pan with pure spring water, over which he holds the male fish in his left hand, keeping the fish's belly under the water, while with his right hand he compresses the fish, and with his fore-finger gently presses out the milt. The female is then taken in hand, and her eggs pressed out in the same way. This process, even under the most skilful handling and the speediest return of the fish to the water, is quite exhausting and is fatal to about three per cent. of the parent trout. Experiments have accordingly been made in this country to arrange wire screens in the ponds on which the trout may natu-

rally spawn, when the thus impregnated ova can be removed to the house. This has been done with success in New York and elsewhere.

The eggs, after forty minutes' contact with the milt, are transferred from the pan to the hatching boxes, and are evenly spread over the clean gravel bed. Over this bed flows a stream of filtered water. The boxes now require watching only with regard to the cleanliness and temperature of the water, and for the immediate removal of any dead ova, which may be known by their change of color. According to the temperature, in from forty to one hundred and twenty-five days the eggs will hatch. For forty-five days the young fish is fed by the "yolk-sack" attached to it, and which is gradually absorbed. The "troutlet" is now an inch and one half in length, and must be fed with beef liver and sweet cream, finely chopped and sifted, mixed with water, and supplied to the boxes through a small syringe, taking care to furnish enough, but not too much, as the food not eaten will foul the boxes and kill the fish. In six months the fish is three inches long, and may be fed with sifted curd. In a year the trout is six inches in length, and is removed to a pond, where he and his fellows will be safe from larger fish, to make room for fresh ova in the hatching-boxes.

The fish may now be fed with finely cut liver, with curds, with grasshoppers, and with small chopped fish. On this diet they thrive, and at the end of the second year will measure from ten to fifteen inches in length. At three years old a trout will weigh three fourths of a pound; at four years, a pound and a quarter.

Breeding other Fish.

The foregoing describes in brief the process of fish-culture as it applies to salmon and trout. With shad, the spawning season is from February to June, according to location. The spawn is put in hatching-boxes, which may be placed in the river to be stocked, and in water at a temperature of 76° the eggs will hatch in eighty hours. The young fish subsist for three days only on the yolk-sack, and thereafter find their own food. The female shad two years old will weigh two pounds; at three years, three and one half pounds; at four years, six pounds. The wonderful fecundity of shad, the ease with which they can be bred, and the fact that they need no subsequent feeding or care, makes them peculiarly profitable for pisciculture.

Fecundity of Fish.

Trout, according to age, will yield from two hundred to four thousand eggs; the average annual yield of salmon is estimated at ten thousand eggs; shad, according to size, yield from fifty thousand to one hundred thousand eggs. The work of the pisciculturist is to preserve this spawn, to make it productive, and so to supply unlimited quantities of the best kinds of fish for market. Already throughout the United States and Europe the entire practicability of fish-farming is manifest in the increased supplies and diminished prices in the city markets.

Profits of Pisciculture.

It is a fully established fact that, properly conducted, pisciculture pays. Apart from the remunerative business of the large establishments, numerous smaller and private hatching-houses, which might be erected on every farm where there is a good stream of water, are abundant proof that artificial fish-breeding, requiring but a small amount of capital, is very profitable. The writer of this article recently saw a fish-farm, by no means one of the largest in the country, which had been in operation only four or five years, and was able, if the proprietor had been willing, to supply all the hotel tables of the near by watering-place with a constant supply of fine trout and bass. When he had secured enough three and four years old fish he proposed to furnish these hotels, and also to erect on his own premises a dining establishment for the accommodation of patrons who might like to catch their own fish from the ponds at a dollar a pound. Two of the ponds fairly swarmed with fish weighing from three quarters of a pound to a pound and a quarter, or of good size for the table. Not long ago a New Yorker offered the fish-farmer two dollars a pound for all he could catch with a rod and line in the four-year old pond in five minutes. It was a bargain; but when he had hooked out a dozen fine fellows "in less than no time," the proprietor implored him to stay his hand, for the trout were worth more to him than the money. The dozen weighed thirteen pounds, and cost the amateur angler twenty-six dollars. The fish-farmer estimated that in another season every trout in his larger ponds — and they numbered thousands — would be worth a dollar. Considering the entire cost of breeding the fish, the profit at this rate is enormous.

WHAT CERTAIN STATES HAVE DONE.

Since 1867 the legislatures of several of the states have enacted laws looking to the re-stocking of their rivers, and the protection for a proper time, and during spawning seasons, of the new supplies of fish. Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and one or two more states, have appointed commissioners to take charge of this matter, and many rivers in these states have been re-stocked with shad, salmon, and trout. Fish-ways have been built in many of the dams; measures have been taken to prevent the fish-breeding streams from becoming common and poisonous sewers; and it is claimed, in 1871, that there has been a marked increase of fish, particularly of shad, in the northern rivers. Fish-culture was begun in 1870 in Alabama, and the subject is attracting much attention in other Southern States. Enthusiastic pisciculturists prophecy that the day is not distant when fine fish will be so plentiful in the northern and eastern markets that a twelve pound salmon will be sold for a shilling.

GAS AND WATER PIPES.

THE NECESSITY FOR PIPES. — THE INCREASE OF THEIR USE IN MODERN TIMES. — THE WATER SUPPLY OF ROME. — THE OLD METHODS OF MAKING PIPES. — THE FIRST WATER-PIPES FOR LONDON. — THE CHIEF ESTABLISHMENT OF THE UNITED STATES FOR MAKING IRON PIPES. — A DESCRIPTION OF ITS EXTENT AND OF ITS PRODUCTION. — DESCRIPTION OF THE PROCESS. — TESTING THE PIPES. — WILLIAM SMITH, THE FOUNDER OF THIS ESTABLISHMENT. — A SKETCH OF HIS PERSONAL HISTORY. — HIS BUSINESS CAREER.

In our modern society the use of pipes for conveying gas or water, or for other purposes, has increased with wonderful rapidity, and has added proportionally to the comfort and health of the inhabitants of our cities and villages. In ancient times the supply of water for a city was a question of prime importance, which could be met only by the expenditure of infinitely greater stores of labor and of money than is required for the same purpose to-day.

As the Romans were unacquainted with the property of water by which it rises to its level, they brought into their cities their supplies of water in aqueducts, which were carried on a level often at great expenditure of labor in building up high arches through the valleys, or in excavating through the higher levels. So prodigious was the labor necessary for supplying the ancient cities with water, that it was only the rich and powerful ones which could undertake it; and the remains of the ancient aqueducts, and the sewers with which Rome was provided, are among the grandest remains of the architectural works of that pre-eminently building city of antiquity.

In modern times, however, with the use of iron pipes, the supply of water and the drainage of even a village has become a task which is not too great for its own resources; while the use of gas is entirely a modern invention which has become practicable only by the invention of the iron pipe, and affords another striking instance of how intimately interdependent upon each other for their successful introduction are all the various branches of industrial progress.

In the progress of modern civilization the necessity for obtaining some method of making cheap and serviceable pipes has been so plainly seen that various methods had been proposed and tried

before the modern iron pipe came into use. Pipes have been made of logs, through which holes were bored. The water supply of London was at first brought in pipes of this kind, made from the trunks of elm-trees; and pipes of this kind are still in use in many parts of the United States, in which the requisite mechanical skill and appliances for making iron pipes have not yet been obtained.

Pipes of this kind are, however, defective, on account of the tendency of the wood to rot, and thus impregnate the water passing through them with decaying vegetable matter. Pipes have also been made of glass, of pottery, and of other substances; and though useful, when made of these materials, for certain uses, yet their cost, their want of strength, or their failure in some other respect to meet all the necessities for a cheap, durable, and strong pipe, which can be readily produced in sufficient quantity to answer the demand for them, has led to their gradual abandonment, and the substitution of iron pipes.

The chief establishment for the manufacture of iron pipes in this country is the National Foundry and Pipe Works, situated in Pittsburg, Pennsylvania. In these immense works, which occupy over six acres, pipes of all sizes, from two inches to six feet in diameter, are produced; and the capacity of the works is such that they can work up two hundred tons of iron a day, their regular consumption amounting to one hundred and seventy-five tons, which can be increased, when necessary, to the above enormous production.

The pipes are cast vertically in moulds. The cavity of the centre is obtained by casting them about a central tube, called the "core barrel." This tube, of the desired length, is wound tightly with a straw rope, which is then covered smoothly with a mortar made chiefly of loam. When this has dried thoroughly, it is covered with a composition intended to prevent the moulding sand from sticking to it, and it is then placed upright in an iron mould or "flask," of the proper length. An iron pattern, corresponding in shape with the pipe to be made, is then put in the flask, and the space lying between the pattern and the flask is filled with sand. The pattern being then removed, the interior of the mould thus made is washed with the same mixture used for washing the core barrel, and the whole thing allowed to dry thoroughly. The heat from a furnace is distributed through the casting-pits, in order to aid the thorough drying of the moulds. When the moulds are dry the molten iron is poured into them, and, after cooling, the mould is

opened and the pipes are lifted out by cranes, and placed on the cooling ground, until they become ready for handling.

An idea of the extent of the business done by the National Pipe Company may be given by a statement of the amount of straw used in making the ropes to bind about the core barrels. The straw used for this purpose is rye straw, and the amount yearly consumed amounts, in value, to about two thousand dollars. The ropes are twisted by machinery, by which a great saving of labor is effected. One of these machines, operated by a boy, will make as much rope as fifty men could twist by hand, and leaves it coiled upon a roller ready for use. Three machines supply all the rope required for the large consumption of the National Pipe Works.

The preparation of the sand for the moulds is an operation requiring considerable care. The sand has to be sifted and kneaded as carefully as a housewife prepares her flour for her bread. The casting-pits are deep enough to cast the pipes in lengths of twelve feet, and there are three of these in this establishment devoted to casting small pipe. These pits contain about sixty flasks each, and produce from six to twelve tons daily, according to the size of the pipe made in them. Each pit is provided with a crane for removing the pipe when made.

The National Foundry is amply provided with all the mechanical appliances necessary for the prompt transaction of its work. Among these the cranes, which are numerous, are perhaps as striking as any other portion of the machinery. Some of these cranes are operated by steam, and several of them have a capacity for lifting seventy-five tons, and with ease and rapidity will lift burdens which would require the combined muscular strength of a regiment of men to move. With these aids the pipes six feet in diameter are handled with as much ease and certainty by the workmen as a boy would handle a pea-shooter.

After the pipes have cooled, and are removed from the pit, their interior surface has to be cleaned from the sand which adheres to it. To undergo this operation they are carried to the Preparing House, where, with scrapers made to fit, the sand is by a few dexterous movements scraped away, coming out in scales and segments of circles.

The pipes are then tested by an hydraulic force-pump, to see whether they are free from imperfections, and able to stand the severe pressure to which their use may subject them. According to their size, and the purposes to which they are to be applied, they

are subjected in this test to a pressure rising as high as five hundred pounds to the square inch. The pipes are finally finished by being immersed in a composition of which tar is the chief ingredient. They are heated to about three hundred degrees, and allowed to lie in the mixture for some time. This treatment makes the pipe better able to resist the action of ammonia, and insures its lasting three times as long as it would, had it not been subjected to it. The pipes, when thus "tarred," have a shiny appearance on being removed from the vat.

Beside these appliances in their regular business of pipe-making the National Pipe Works has a regular machine-shop, provided with lathes, planers, and the other necessary appliances for performing all the machine-work, the blacksmithing, and the model-making required by the establishment. The power for carrying on the complicated and extensive operations of the company is furnished by several engines, and the hands employed in the various branches of the business reaches a total of over five hundred persons.

The successful establishment of this vast industrial establishment is due to the persistent energy and untiring perseverance of the proprietor, Mr. William Smith, who, starting in life with no adventitious aids, has by his own industry and enterprise built up the business to its present gigantic proportions. Among the numerous instances which this country affords of the rewards which the freedom of our social and political relations offers to industry and enterprise, this case of Mr. William Smith is perhaps as striking as any. Commencing his industrial career at the very foot of the ladder, he began as a young man by obtaining employment at the rate of sixty cents a day, as a helper. From this position he soon rose to become an assistant, with a slight increase of daily pay. Being frugal, as well as industrious and ambitious to advance, he managed to lay aside a little even of the small amount of money which he was then gaining, and in the fall of 1843 his brother, who had noticed his intelligent devotion to business, proposed that they should form a partnership, which was done, and the new firm commenced their career, under the title of John and William Smith, in the foundry business. Their establishment was known as the "Carron Foundry," and was devoted exclusively to the production of butts, or hinges, wagon-boxes and smoothing-irons. It was situated on Penn Street, Pittsburg, and the original sign of the firm could quite recently have been seen, remaining in its position, upon the side of the building.

After continuing the business for two years, the balance-sheet from the books showed that the firm had lost fifty dollars by their operations. Mr. John Smith then retired from the firm, and Mr. William Smith, with his confidence and determination unabated by this apparently undeniable evidence of the impossibility of success, continued the business, having taken as partners Mr. John Wright and Mr. John Van Winkle, and changed the name of the firm to Smith, Wright, and Company.

The existence of this firm was even shorter than that which it replaced; though its business operations were quite successful, yet the financial condition of the country, the scarcity and dearness of money, and other causes, caused its dissolution in 1846, after it had continued in existence but little over a year. Notwithstanding the apparently unsuccessful termination of this new experiment, caused by circumstances so general in their character as to be beyond his power to control them, Mr. William Smith still felt confident of his ability to eventually succeed, and was the more strengthened in his determination to do so by the increase of the business which had been made during even this short period, while the conditions were so unpropitious.

In this next change, Messrs. Wright and Van Winkle retired from the firm, their interests being purchased by Mr. Jacob Painter and Joseph Jenks. With the foresight which has characterized the whole course of Mr. Smith's business career, he determined to attempt to supply the cotton-manufacturers of Pittsburg with the castings and the machinery which they then relied upon New England to supply. The business of cotton-spinning had then entered upon the course of development in this country which has resulted in its attaining its present importance, and the industrial enterprise of Pittsburg had begun to turn its attention to this new branch of employment. Up to this time, however, all the supplies of machinery, as well as the castings needed for repairs, had been obtained from New England; and there was a prejudice in the minds of those engaged in the business in Pittsburg, that they could not obtain at home the material they required as well as they could abroad. Knowing, however, that they were mistaken, Mr. Smith tried to convince them that they were, but had hard work to do so. Having finally persuaded some of them to allow him to try and produce for them some of the castings they needed for repairs, his success soon convinced them that they had at hand a man who could supply their needs as well, and at cheaper rates

than they could obtain their castings from abroad; and thus the foundation was laid of the business, which finally, in the hands of the firm of Jenks, Painter, and Company, became celebrated throughout the West for its skill and reliability in manufacturing cotton-spinning machinery.

While Mr. Smith was connected with this firm his energy extended their business so that they were called upon to prepare the machinery for various manufacturing establishments in different parts of the country. Upon one occasion, having gone himself to superintend the erection of a large cotton-mill in Memphis, Tennessee, and stock it with machinery of his manufacture, the business ability of organization which he displayed struck the proprietors so favorably that they offered him a large salary if he would stay and oversee it; and, as a further inducement, to give him a plantation, with an ample supply of slaves. His native independence of character made, however, the holding of slaves so distasteful to him that he politely but firmly refused the offer.

In 1854 Mr. Smith, having dissolved his connection with his partners, determined to establish another foundry, and purchased the ground which is now occupied by the National Foundry and Pipe Works. His judicious business foresight was displayed in the selection of this site; his friends, to whom he mentioned his design, advised him strongly against it, telling him that the position was too far out of the town, and that it was certain that the enterprise would consequently prove a failure.

With a confidence, however, in his own judgment, which his experience had naturally created, and which the result has justified, Mr. Smith persisted in carrying out his plans, and has never seen any cause to regret his so doing. The first building he erected for his foundry measured forty feet by seventy, and in October, 1854, he melted his first run. That day, as he expressed it, was the proudest one of his life: he was in business for himself.

At first he had only two assistants, and began with melting only once a week. Devoted to his business, he was at once proprietor, moulder, business manager, bookkeeper, and filled any other position which required filling. This indefatigable perseverance met its reward, and soon the business had so increased that it became necessary to melt twice a week. Encouraged by his success, he dared to look forward hopefully to the time when the requirements of the business should be such as to consume a ton a day of casting.

In 1855 the business had so increased that he was forced to take a partner, to relieve him of a part of the various duties he had hitherto performed, and the style of the firm was changed to Smith and Company. This partner, Mr. Dixon Brown, having died in 1858, Messrs. David E. and James Park, Jr., purchased his interest, and the firm's name was again changed to Smith, Park, and Company.

In 1865, however, with other changes, Mr. Smith purchased the interests of these gentlemen in the firm, and has since conducted the business in his own name, and confined his operations to one special branch, instead of doing a general foundry business. Re-christening his works as the National Foundry and Pipe Works, he entered then upon the career which has made his establishment the largest in its specialty in the world.

With the wise foresight which he has always shown, Mr. Smith has also become interested in a company owning and operating coal and iron mines at Ursina Station, on the Baltimore and Ohio Railroad. The lands of this company consist of 6,430 acres, containing almost inexhaustible supplies of coal, and also in the Isabella Furnace Company, which has now in operation two of the largest blast furnaces for the manufacture of crude iron in the country. Beside these he is also interested in the Cascade Iron Company of Lake Superior, whose lands comprise 3,625 acres of ore sand, and 2,000 acres of woodland, and upon which there is already a furnace in operation. By these means, being able to control the production of the raw material needed for the specialty to which the National Foundry and Pipe Works are devoted, Mr. Smith looks forward to a still greater increase of the present enormous business which is there carried on.

As, too, he controls, by several patents of his own inventions, and by others which he has obtained by purchase, the best improved methods for the making of pipes, there is little or no question that the future of his business career will be marked by the same increasing growth and improved organization which have in the past made it distinguished among even the most remarkable business successes of the United States.

NEWSPAPERS.

ORIGIN OF NEWSPAPERS. — MANUSCRIPT NEWS LETTERS. — FIRST PRINTED JOURNAL IN ENGLAND. — FIRST DAILY PAPER IN LONDON. — PROGRESS OF THE PRESS. — WILKES, HAZLITT, HUNT, LAMB, SOUTHEY, COLERIDGE, WORDSWORTH, BLANCHARD, JERROLD, DICKENS, AND THACKERAY, AS JOURNALISTS. — AMERICAN NEWSPAPERS. — FIRST NEWSPAPER IN THE COLONIES. — ITS BIRTH AND SUDDEN DEATH. — ESTABLISHMENT OF JOURNALS IN DIFFERENT LOCALITIES. — BENJAMIN FRANKLIN AS AN EDITOR. — FIRST DAILY IN NEW YORK. — THE OLDEST NEW YORK PAPERS. — THE GREAT WEEKLIES. — BENNETT, BRYANT, BONNER, RAYMOND, AND GREELEY. — ACTIVE COMPETITION. — NEWS BOATS. — EXTRAS. — PONY EXPRESSES. —STEAMSHIPS AND RAILROADS. — THE MAGNETIC TELEGRAPH. — ASSOCIATED PRESS. — ATLANTIC CABLES. — RIVAL ASSOCIATIONS. — THE CIVIL WAR. — GROWTH AND EXPANSION OF THE NEWSPAPER BUSINESS. — JOURNALISM A PROFESSION. — BRANCH OFFICES. — THE SUNDAY PRESS. — IMPROVED PRINTING PRESSES AND OTHER MACHINES. — SUPERIORITY OF AMERICAN NEWSPAPERS. — REPRESENTATIVE AMERICAN JOURNALS.

THE history of newspapers really begins with the written news letters circulated from hand to hand and place to place in Europe in the fifteenth and sixteenth centuries. Such manuscripts were issued in England, at intervals, whenever important news was to be communicated, as early as the reign of Henry VI. The invention of the art of printing was applied first and principally to book work, especially to the production in cheaper form of the hitherto costly manuscript copies of the classics and the Scriptures; but the adaptation of the art to the dissemination of news was soon apparent, though the progress of this kind of publication, considering its importance, was, for two centuries or more, astonishingly slow.

The first printed journal in England, giving the news of the week, was issued in 1622. Reports of the daily proceedings in Parliament were issued in 1640. Next came a succession of papers, called the "Newes," one of which was first made a medium for advertising in 1648. Then followed a series of "Mercurys." The first strictly commercial paper appeared in London in 1657;

the first literary paper was published in 1680; a sporting paper was issued in 1683; and a medical journal in 1686.

The first daily paper appeared in London in 1702, and in the course of fifty years from that time, there were a large number of monthly, weekly, and daily journals. In the last half of the eighteenth century, political journalism assumed an importance in London, when John Wilkes edited the North Briton. Edmund Burke contributed to the Englishman, and the Public Advertiser printed the famous Junius letters. Later still came the Chronicle, Post, Herald, and Advertiser — all daily morning journals, some of them employing the pens of prominent statesmen, while for a long time the Post numbered among its contributors such men as Wordsworth, Coleridge, Lamb, and Southey. The daily Universal Register, started in 1785, became, in 1788, the Times, the leading journal of the world to-day. The Times was the first to apply steam power (in 1814) to its press. (See Printing and the Printing Press.) The progress of the daily press in England was now rapid, and new journals constantly appeared. Before 1840, such men as Hazlitt, Leigh Hunt, Laman Blanchard, Dickens, Thackeray, Douglas Jerrold, Robert Owen, and other eminent writers, had made their mark as journalists. The Illustrated London News was established in 1842, and has attained an extensive circulation. The abolition of the stamp duty, in 1855, gave an immense impulse to the newspapers of Great Britain, enabling them to reduce their price and increase their circulation. Besides the literary, illustrated, and humorous papers now published, every shade of politics, nearly every proposed social reform, and almost every profession and trade, has its representative organ in the British press.

The limits of this article will not permit even a brief review of the rise and progress of the newspaper press on the continent. The history and growth of journalism in the United States is more interesting and more important, because in this country journalism has been at no time since the Revolution seriously restricted by censorship, or hampered by stamp acts. Americans are a news-seeking and news-buying people; no nation so freely uses the telegraphs, or pays more for gathering intelligence; and no country, in proportion to its population, prints and circulates so many newspapers. The general diffusion of intelligence and education in the United States is scarcely more due to the excellent and universal common school system than to the numerous and

cheap weekly and daily publications which penetrate to every corner of the country.

Newspapers began in the colonies with the publication, in 1690, in Boston, of the first and only number of a paper, which was at once suppressed by the authorities. In the same year one number of the London Gazette, containing important news, was reprinted in New York. The Boston News Letter was published weekly from 1704 to 1776. The Gazette, in Boston, and the Mercurie, in Philadelphia, followed in 1719. James Franklin started the New England Courant, in Boston, in 1721, and the year following, on account of some difficulties with the authorities, he cancelled the indentures of his young brother, Benjamin Franklin, then sixteen years old, in order to make him the responsible publisher of the paper. The first newspaper in New York was the Gazette, in 1725. Two years afterwards, the Maryland Gazette was printed at Annapolis: following this was the South Carolina Gazette, at Charleston, in 1731; the Virginia Gazette, at Williamsburg, in 1736; the North Carolina Gazette, at Newbern, and the Connecticut Gazette, at New Haven, in 1755; the New Hampshire Gazette, at Portsmouth, in 1756; and the Connecticut Courant, at Hartford, in 1764. The Pennsylvania Packet, or General Advertiser, established as a weekly in 1771, became the first daily paper in the country in 1784. The year following, the Daily Advertiser appeared in New York. The still preserved copies of some of these earlier American journals are curiosities in size, paper, typography, the antiquity of the "news" when printed, and the absence of editorial expression of opinion. They were the crude beginnings of American journalism as it is at present; but they were not, as newspapers are now, an almost complete history of the world's doings from day to day.

With the rapid growth of newspaper enterprise in this country in the present century, it would require a volume to give the names merely of the journals which have been born, have lived their brief existence, and have died. The oldest newspapers in New York are the Commercial Advertiser, dating from 1797, and the Evening Post, established in 1801. The Journal of Commerce was founded in 1827; the Sun 1833; the Herald in 1835; the Tribune in 1841; the Times in 1850; and the World in 1860. These are among the most successful and best conducted journals published in this country, or in the world. The Sunday papers of New York — not only the Sunday issues of three or four of the

daily journals, but papers published only on that day — print very large editions, and some of the New York weeklies, like Harper's, the Ledger, Frank Leslie's Illustrated Newspaper, and others, have attained an enormous circulation, far greater than that of similar publications abroad. The names and prominence of certain editors, such as Bonner, of the Ledger, Bennett, of the Herald, Bryant, of the Evening Post, Raymond (when he was living), of the Times, and Greeley, of the Tribune, have given their journals a reputation and a corresponding circulation. The American press is cordially appreciated, too, as a medium for advertising, and in no other country are the people more ready to make their wants and business known through the columns of the press.

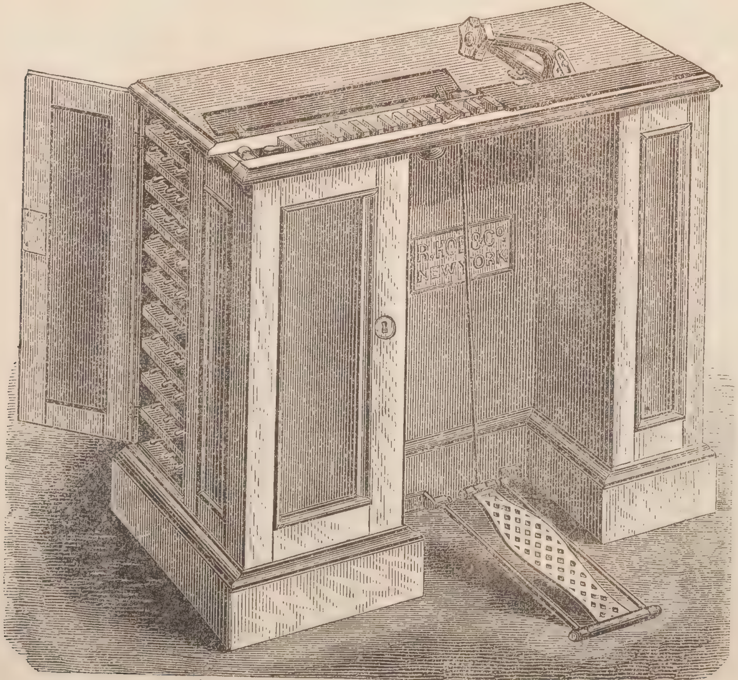
The most active competition in news-gathering and printing has made the United States daily press what it is now. Enterprise in this direction began with the Journal of Commerce, in 1828. There were then no ocean steamers or electric telegraphs; but there were fast packets between Europe and America, and the Journal of Commerce set afloat a swift-sailing schooner which intercepted in-bound ships off Sandy Hook, procured the news and foreign papers, from which an editor on board the schooner made up his "copy" in readiness for the printer the moment he landed. This was the beginning of the afterwards common "Extra," giving the news while it was "news," and in advance of slower rivals. Soon after, the same paper built another fast news boat, and the remaining city papers, in self-defence, associated in running a news boat for themselves and the lively competition to get and print the news first was greatly to the benefit of the public, as well as of the successful journals. "Pony expresses," as they were called — meaning relays of horses with bold riders, to bring election returns from all parts of the state, or adjoining states — next followed. Before the days of railroads there were pony expresses between New York and Washington, and between other important points, whose runnings kept pace with the running of the printing press. News at any price must be obtained, and the rivalry of the journals kept the public well supplied with the latest news and good papers at reasonable prices.

The increasing size and circulation of the journals demanded and made room for special departments, such as money and commercial articles, market reports, ship news columns, law and police reports, a greater attention to local affairs and city items, and verbatim reports of important speeches and proceedings in public meetings.

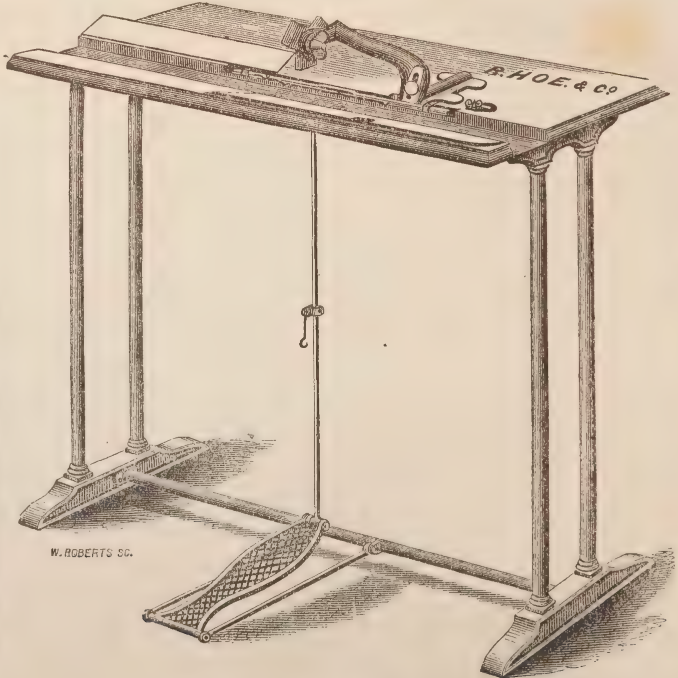
The general application of steam power and the vast improvement in printing presses of American invention immensely increased the importance and circulation of newspapers. Many a now great newspaper in the country, which began its printing on a hand press, has progressed by rapid steps from a two cylinder to a four, six, eight, and ten cylinder press, as its increasing business demanded. The establishment of steamship lines, the spread of railways, and above all, the invention of the magnetic telegraph, and the successful connection of continents by means of sub-marine cables, have enabled the journals of every city in the United States to spread before their readers, every morning or evening, the important news, the day's history, in fact, of the whole world. This progress in journalism has not been confined to the great cities on the Atlantic board, but it has extended throughout the country, till every locality, east, north, west, and south, has its representative journals, which display all the ability and enterprise so characteristic of the American press.

Before the laying of the first Atlantic cable, the establishment of a telegraph line to Farther Point, where news by the European steamers was taken off and transmitted, shortened the time of communication with Europe, and led to the establishment of the "Ship News Association," which, by the joining in of leading papers throughout the Union, became the "Associated Press." This enterprise necessitated the location, at every important point, of skilled news-gatherers, who collected and telegraphed whatever was important; the associated journals using the news, and each paying its proportion of the cost of collection and transmission. To this association, several of the papers, particularly at the west, opposed a rival association in 1863, the result greatly benefiting the public, in increasing, and, to some extent, cheapening the news. The civil war, from 1861 to 1865, developed the fullest resources of American newspaper enterprise. No expense was spared in the use of the telegraph, sending of special correspondents to every point, and the employment of messengers and horses in gathering details from every corner of the seat of war. For important news "extras" were issued, sometimes three or four times in a day, and the sale of papers was enormous. Frequently a local event of extraordinary interest — for instance, the riot in New York, July 12, 1871 — will double the ordinary daily issue of some of the city journals.

A most noticeable feature in the progress of newspapers in the



NEWSPAPER ADDRESSING MACHINE,
(With Cabinet Case.)



NEWSPAPER ADDRESSING MACHINE,
(With Iron Stand.)

United States is the employment of men of the highest culture as editors, writers, and correspondents. Journalism is now a recognized profession, which includes many of the most cultivated men in the country. The larger journals employ full staffs of editorial writers, reporters, heads of special departments, and special correspondents ; and have agencies, which are branch offices, at Washington, London, Paris, and other leading localities. American journals pay more money by far for news from all quarters, than do the newspapers of Great Britain or the Continent. With the vast improvements in printing presses, American ingenuity has been active in inventing newspaper folding and directing machines, which greatly facilitate the speedy transmission of papers by mail. In spite of the boasted superority of the London Times, the leading journals of New York and of some other American cities are unsurpassed as able and enterprising *news*papers by any journals in the world.

The entire number of newspapers and periodicals now (1871) published in the United States and Territories is six thousand and fifty-six, of which five hundred and ninety-four are daily, four thousand three hundred and eighty are weekly, tri-weekly, semi-weekly, bi-weekly, bi-monthly, and quarterly. The influx of foreigners has necessitated the publication of a large number of papers in foreign languages. The German papers number three hundred and forty-one ; French, in New York and New Orleans, seven or eight ; Spanish, seven ; Scandinavian, in the west and north-west, eighteen ; Dutch, six ; Welsh, three ; Bohemian, two ; Portuguese, one ; and the Cherokee Indians have a newspaper in their own language.

Eleven papers print editions of more than one hundred thousand copies. Five hundred and forty-eight papers print editions of more than five thousand copies. New York has the largest number of publications, to wit, eight hundred and ninety-four, of which New York city has three hundred and seventy-one.

Of daily papers, New York has eighty-nine ; Pennsylvania, sixty-one ; Illinois, thirty-eight ; California, thirty-four ; Ohio, twenty-five ; Massachusetts, Missouri, and New Jersey, each twenty-one ; Indiana and Iowa, each twenty ; Connecticut, seventeen ; Virginia and Wisconsin, each sixteen ; Tennessee, twelve ; Texas, eleven ; and other states from one to ten daily papers each. The total annual circulation of all the papers and periodicals in the United

States and Territories is estimated at the enormous number of 1,436,551,619 !

The American Newspaper Directory of Messrs. George P. Rowell & Co., of New York, estimates that from March, 1870, to January, 1871, more than one thousand new newspapers were established in the United States, and that the number of newspapers started since the beginning of 1871 averages four a day, while the suspensions are about one fourth as large as the number of the new issues ; it is believed that within six years the number of newspapers in this country has doubled.

About one thousand papers, principally in the interior towns, buy, at New York and at Chicago, papers printed with general news and miscellaneous matter on one side, leaving two pages for local news, advertisements, and editorials. This "auxiliary plan" has long prevailed in Great Britain, and is becoming popular in this country. The economy in composition and other labor is a considerable saving to country papers.

Of papers devoted to specialties, the religious papers take the lead, and number two hundred and eighty-three ; of farming, horticultural, and stock-raising journals there are one hundred and six, many of them profusely and expensively illustrated ; medical journals number seventy-two ; insurance business is specially represented in nineteen publications ; of college papers and educational journals there are eighty-four ; and freemasonry, temperance, law, music, odd fellowship, mechanics, real estate, sporting matters, etc., etc., have their special organs.

MATCHES.

THE NECESSITY OF FIRE TO MAN. — THE TRADITION OF ITS DISCOVERY. — THE CARE USED IN GUARDING IT IN ANTIQUITY. — THE FLINT AND STEEL. — CHEMICAL METHODS. — THE FIRST MATCH. — THE FIRST AMERICAN PATENT. — THE EXTENT OF THE MATCH BUSINESS. — THE SWIFT AND COURTNEY AND BEECHER COMPANY. — THEIR ESTABLISHMENTS. — THE MACHINES THEY MAKE. — THE EXCELLENCE OF THEIR MATCHES. — A HISTORY OF THEIR BUSINESS CAREER. — THE PROCESS THEY USE. — THE LESSON OF THE MATCH BUSINESS.

THE utility of fire is so great to mankind, and it is such an apparently inexplicable phenomenon, that there is no wonder tradition accounted for its possession by the story that it was furnished directly to man by divine agency. The mythological fable that Prometheus was punished by the angry gods for having stolen fire from heaven, and, by imparting to men a knowledge of its use, enabled them to contend with the gods in power and knowledge, expresses, as was the spirit of those times, in a dramatic story, the importance to mankind of a knowledge of the uses of fire, and also the superstitious fears of the powers of nature, which are so characteristic of an age of scientific ignorance. To the ancients the fact of burning was so mysterious and inexplicable that a flame was made an expression of their religious worship, and used as a symbol of their adoration of their divinities; nor has this custom yet entirely disappeared from the world. To the modern chemist, however, burning is simply a process of rapid oxidation, and a flame is merely one of the indications of the chemical affinity of two substances, differing in intensity only from the rusting of a nail, but no more than this ordinary process symbolical of any special sentiment of worship.

It would be interesting, as a matter of mere curiosity, to know exactly how the first man who made use of fire, for any purpose, obtained it. Most probably it was supplied to him by some case of spontaneous combustion, or from some tree set on fire by light-

ning. Of course, however, this must be mere conjecture, though it is evident that it was a long time after the use of fire was known before simple and efficient means were discovered for obtaining it at will. This appears from the care with which it was guarded when once obtained. The Hebrews, as appears from their records, carried it carefully with them from place to place, as the North American Indians were in the habit of doing before the early settlers of this country taught them the use of the flint and steel. Various methods for obtaining fire were discovered during the history of human society, and with the increasing knowledge gained by the experience of successive generations these means have constantly increased in simplicity and in certainty, until we have reached that of the modern match, which has resulted from the application to the arts of the knowledge of chemistry, which is peculiarly a modern science.

Before the idea of using chemical mixtures for obtaining fire came to be practically applied, the chief device used was the flint and steel. By striking these together sharply, a spark was elicited, which, being caught upon a bit of tinder, could be blown into a flame. Despite the inconvenience and trouble incident upon the use of this appliance for obtaining fire, it was for a long time the best in use.

About the middle of the seventeenth century it was discovered that phosphorus, by friction, would ignite the end of a stick which had been dipped in sulphur. Phosphorus did not, however, come into general use, as a means of obtaining fire, for more than one hundred and fifty years after this discovery; but in the interval several modes of using it for that purpose were devised. Those of us who are not too young can still remember this matches of fifty years ago. They were made of small sticks, the end of which had been dipped in melted sulphur. With these and a vial containing oxide of phosphorus, produced by partially burning a bit of phosphorus in the confined air in the vial, our fathers prided themselves upon the improvements made in the methods of obtaining fire at will. This commencement having, however, been made in using chemical means for obtaining fire, in the place of depending upon friction, as had been done before, ingenuity naturally turned its attention to bettering the process, and the first great improvement consisted in combining chlorate of potash with the sulphur upon the end of the match, so that when dipped in sulphuric acid the match was lighted. Though this was

an advance, yet, compared with our present matches, this method was very clumsy. It required that the person using the match should also be provided with a vial of sulphuric acid.

In 1829, however, an English chemist discovered by experiment that chlorate of potash would ignite by friction ; and with this discovery the era of our present matches was inaugurated. Improvements in their preparation were made by Professor Faraday, whose contributions to the scientific knowledge of the world are so well known, and at his suggestion nitre or saltpetre was used in the place of chlorate of potash, in order to avoid the explosion made by the ignition of this latter substance ; while, by a mixture of stearine with the sulphur, the objectionable fumes of this substance were lessened. In the United States the first patent for the invention of friction matches was granted to Alonzo D. Phillips, of Springfield, Mass., October 24, 1836. The chemical mixture used by him consisted of glue, phosphorus, chalk, and sulphur. Since that time the manufacture of matches has greatly increased, and various other patents for improved methods of manufacture have been granted to various claimants, and the match business has become a very important one. The extent of the business is shown by the fact that the government derives from the tax upon matches a yearly sum of two millions of dollars.

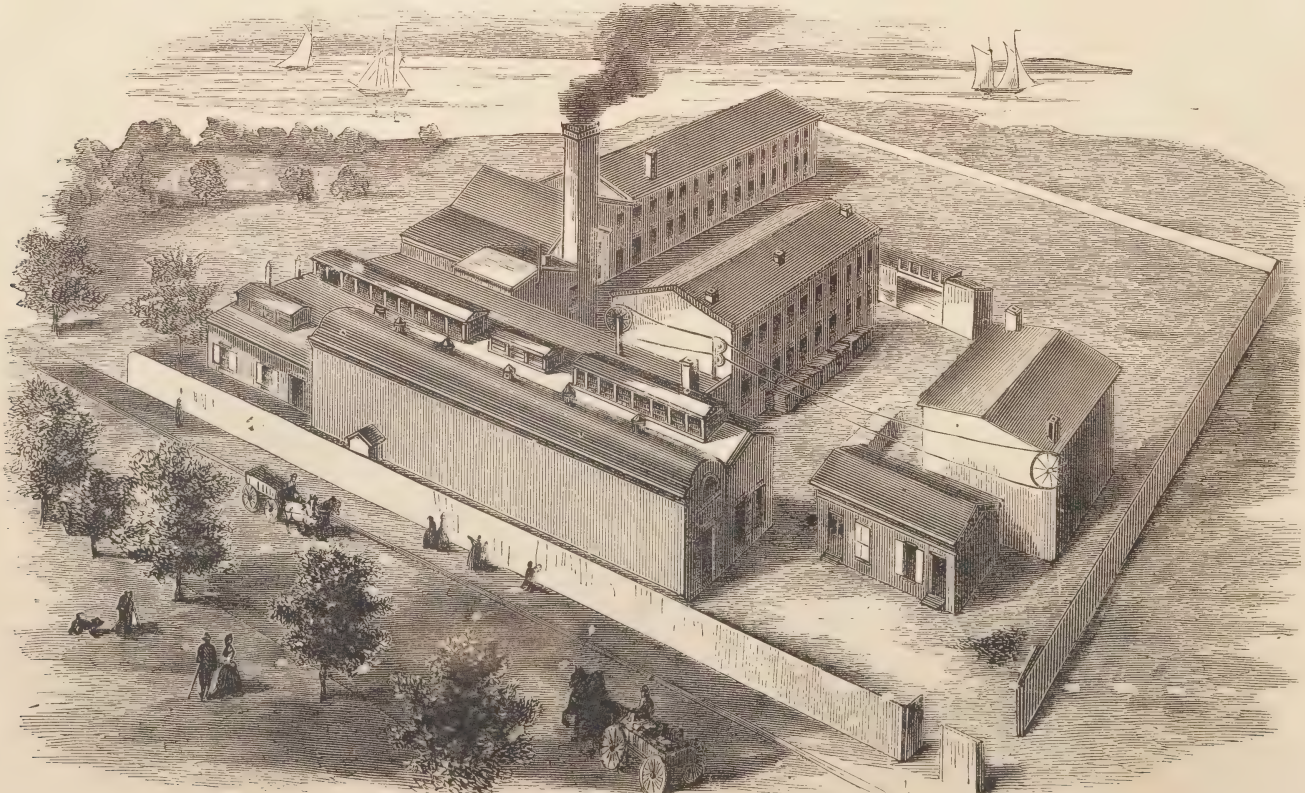
The manufacture of matches as a special industry may be said to have fairly begun in the United States in 1836, although at that time there were very few factories in operation, and these few very small ones.

The proportions attained by the match business, in the short time which it has been in existence, have become possible only by the introduction of machinery to the manufacture. At first all matches were made by hand, the splints being whittled out. At present, however, all the operations which can be are done by machines. An account of the methods used in the establishments of the Swift & Courtney & Beecher Company will best serve to give an idea of the present condition of the manufactures in this country. This company has three manufactories, one in Wilmington, Del., another in Westville, Conn., and a third in Chicago, Ill. We give representations of the first two. The present company was formed in May, 1870, by the union of the firm of A. Beecher & Sons, which was established in 1850, at Westville, Conn., and that of Swift & Courtney, which was established in 1854, at Wilmington, Del.

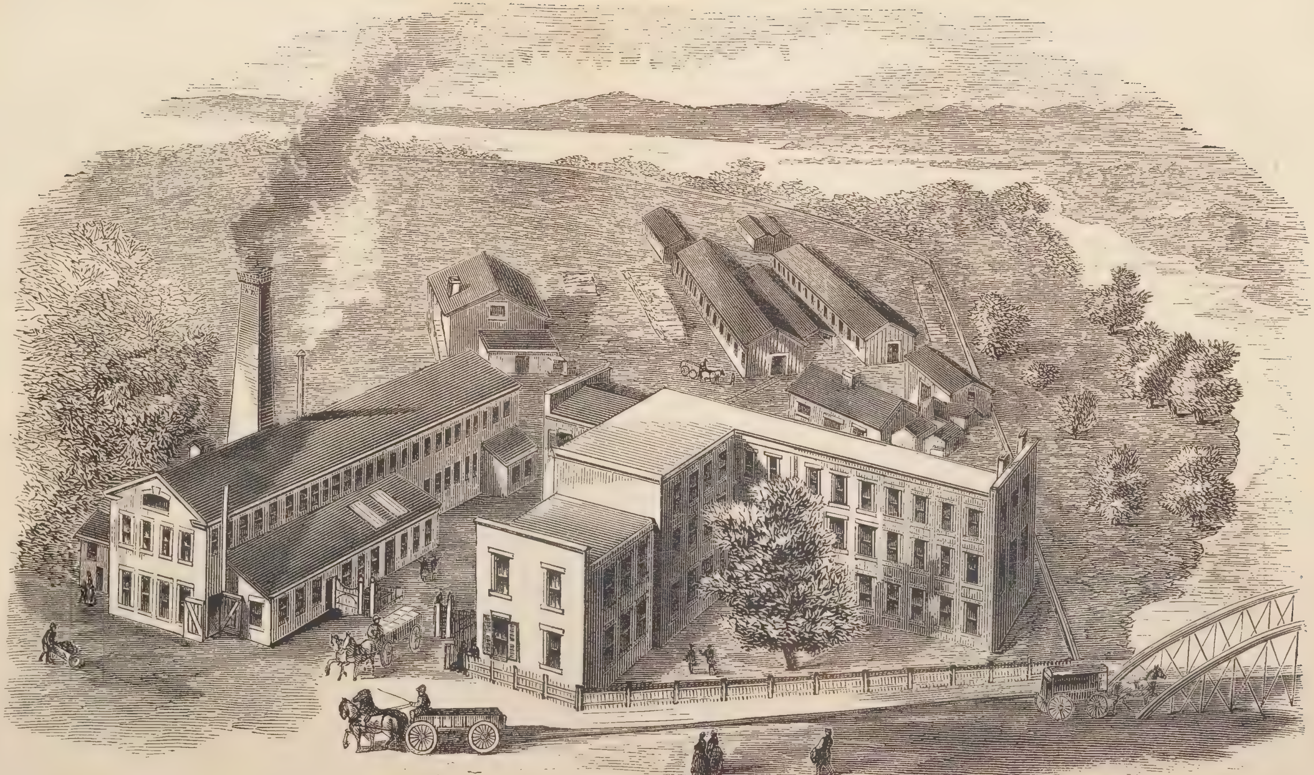
The Wilmington branch was founded by Mr. Edward Tatnall, with Mr. Courtney as foreman and practical manager, Mr. Courtney having from his boyhood been engaged in making matches, when the hand process was the only one in use.

The business was commenced in a one-story building containing sixteen hundred and fifty square feet of floor room. Under the direction of the original founder the business did not make any great advance; and in July, 1861, he disposed of his interest to a new firm, composed of William H. Swift and H. B. Courtney, who, under the title of Swift & Courtney, continued the business until the present company was incorporated, in May, 1870. Under their management the business was greatly increased, and such additions to the premises as were necessary to meet the growing wants of the business were made from time to time, until they now occupy an entire block, with buildings which furnish twenty-eight thousand square feet of floor room. This firm were the pioneers in the business of making matches without sulphur in this country; they originated the name "parlor match," and adopted it for their matches, the merits of which have brought them into general consumption. They have constantly adhered to their high standard in the quality of the goods they offered for sale, and thus, despite the imitations of their special wares which have been made by others, the demand for the parlor matches of their make has become general, not only throughout the United States, but in South America and other countries. With the Wilmington branch of this company the manufacture of parlor matches is a specialty, and they confine their attention exclusively to that grade of match; but at the Westville and Chicago branches, besides the parlor matches, they also make sulphur matches of a superior quality.

The Westville branch of the company was established as the firm of A. Beecher & Sons, in 1850. The three members comprising this firm were the inventors of the machines used in match-making, and the extent and importance of the match business at the present day in this country is due chiefly to their mechanical skill and ingenuity. It would have been impossible, under the old system of hand labor, to accomplish the results which they have made attainable by the application of machinery. One of the branches of the company's business at Westville is the manufacture of these machines, which are in use in every match factory in the United States and in Canada, and, being protected by letters patent, are manufactured only here. These machines comprise



FACTORY OF THE SWIFT & COURTNEY & BEECHER CO., AT WILMINGTON, DEL.



FACTORY OF THE SWIFT & COURTNEY & BEECHER CO., AT WESTVILLE, CONN.

the stick-cutting machine, which prepares the splints either round or square; the setting machine, by which the splints are arranged in bundles, each one being kept distinct from all the others, so that, in the process of dipping the splints, each of them shall receive its share of the mixture without interfering with its neighbor; the rolling-off and cross-cutting machine, by which the bundles of splints, after they are dipped, are unrolled and cut into halves; dripping apparatus, composition mixers, and machines for scoring and cutting paper for boxes.

This firm also built up their business from a small beginning, and have increased the capacity of their buildings, until they now have an area of floor room of about thirty-three thousand square feet.

At Westville the splints are made and shipped to the other factories, to be worked up into matches. The lumber used is selected pine, which comes chiefly from Canada and the Hudson Bay Company's possessions. The Swift & Courtney & Beecher Company employ during the season three or four gangs of men selecting it. After being received at the factory, the lumber is kept stored for a year in order to season, and is then sawed to lengths equalling two matches, and cut into splints by the machines. These machines work with great rapidity, a single machine making two million splints every ten hours. The splints are then, by another machine, rolled into bundles measuring about eighteen inches across, each splint being kept isolated from every other. The dipping process is then gone through with. The mixture, of a pasty consistency, is spread upon a flat slab of stone, and the workman, taking a bundle, rapidly dips one side, and then, turning it over, dips the other side. By the simplification of the process, a workman can dip a million matches in an hour. The matches are then dried, and by another machine the bundles are unwound, and at the same time the splints are cut into two, and the matches are then delivered to the boxers. These are generally girls, who acquire great dexterity in their manipulation. Provided with a pile of boxes, and another of matches, one of these boxers soon acquires the knack of taking up just enough matches to fill a box, and, by a peculiar shuffling motion, arranges them with great rapidity in the box which she has taken and opened with the other hand. The boxes are then stamped and packed, ready for sale.

In their three establishments the Swift & Courtney & Beecher Company employ about four hundred hands, the chief portion of

whom are women and girls, and the average of their production is fifteen hundred gross a day. The care of inspection, which is necessary to keep the standard of their goods at the point of excellence which has given them their reputation, is very great; but the skill and long experience of the members of the company secure the proper performance of this important duty. The factory at Chicago was established to partially relieve those at the east from the demand for the western markets, and, though established only in 1871, has already, by the exercise of the same enterprise and care which have given the parent branches their reputation, earned such a success as could confidently be looked for.

Perhaps in no single department of our varied industry is the course of the business of the modern world more clearly indicated than in this of matches. This branch of manufacture, which forty years ago was hardly in existence, or was carried on in the smallest way, has now reached such proportions as afford employment for companies like this, with a large capital, every appliance of machinery, giving employment to hundreds of hands, drawing its necessary supplies of material from distant points, and sending its productions to various countries. The necessity for the union of mankind, as a necessary result of their interdependence, is thus shown practically from our industrial growth, as it is from the widening scope of our philosophy.

THE AMERICAN MAGNETIC TELEGRAPH.

THE ETYMOLOGY OF THE WORD "TELEGRAPH." — THE TELEGRAPH OF ANCIENT TIMES. — THE AMERICAN ELECTRO-MAGNETIC TELEGRAPH, COMMONLY KNOWN AS THE "MORSE TELEGRAPH." — WHAT IT IS. — WHO INVENTED THIS TELEGRAPH. — THE UNVEILING OF A STATUE OF PROF. S. B. F. MORSE, AND THE GREAT FARCICAL DEMONSTRATION AT THE ACADEMY OF MUSIC, TO HIS GLORY, JUNE 10, 1871. — OF SUNDRY "EMINENT MEN," MERCHANTS, EDITORS, ETC. — AN INVENTOR DEFINED, AND PROF. MORSE MEASURED BY THE DEFINITION. — AN UNEQUALLED PIECE OF IRONY. — CHIEF JUSTICE CHASE. — FURTHER INQUIRY INTO PROF. MORSE'S CLAIMS. — PROF. JOSEPH HENRY. — PROF. LORENZO D. GALE. — MR. ALFRED VAIL. — WHO THE REAL INVENTORS OF THE PRACTICAL ELECTRO-MAGNETIC TELEGRAPH WERE. — HON. FRANCIS O. J. SMITH IN HIS RELATIONS TO THE TELEGRAPH. — PROF. MORSE AS A RHETORICIAN AS WELL AS AN "INVENTOR." — PROF. MORSE AS A "PROVIDENTIAL HYPHEN." — THE WESTERN UNION TELEGRAPH COMPANY, AND ITS SPECULATIVE SCHEMES.

Among the marvellous accomplishments of human study and genius, nothing, all facts considered, can well be regarded as more important than man's triumph over space and time in the matter of the intercommunication of widely separated individuals and nations. From the earliest times some mode of conveying intelligence to a distance by a more expeditious and less expensive process than that of actually sending it by couriers has been resorted to, such as by fires built upon hills or mountains far remote from, but with their peaks within sight of, each other. This method was carried to such perfection by the Romans at one time, that, as Julius Africanus relates, they were enabled to convey messages with much rapidity to great distances in words, the letters being indicated by different colored lights.

The method of transmitting intelligence by means of signs, observed from distant points, has long been denominated a *telegraph* — a word derived from two Greek words, *tele*, far off, and *graphein*, to write, and seems to have been in use for many centuries, up to about 1845, as exclusively indicating some kind of visual, far-off, or signal writing, or telegraphy. But when the electro-magnetic means,

with its mechanical correlations, became an established accomplishment of science for the conveyance of intelligence, the word *telegraph* was assigned as its name, and is now universally understood as signifying that alone; and we purpose to speak in this article of little else than the Electro-Magnetic Telegraph, and its inventors and promoters.

A thorough dissertation upon the electro-magnetic telegraph, and the numerous matters of dispute which have arisen as to its origin in the long line of scientific research which eventuated in its suggestion, and the painful years of mechanical experiment which resulted in its realization as a mighty "power in the earth," would fill a large volume, and will, doubtless, at no very distant time, be written, as it should be, for the interests of science and truth.

The electro-magnetic telegraph, though in the general understanding classed as an "invention," was, properly speaking, a slow creation of science, step by step; a growth of many years; not the suggestion of a single instant, or the discovery of a single mind.

It is hardly necessary to comment upon the immense value of the telegraph to our present civilization, and the great changes it is silently and steadily working in conjunction with other forces of progress in the world's modes of thought and customs, all pointing to those days of enlightenment when the race will look back with mingled contempt and pity upon the hideous moral slaveries, the wretched social isolation, the cowardice, the ignorance, the bigotry, the false religions, and other of the indecencies and unscientific conditions of present times, in which men and women are nearly all monstrously deformed, or dwarfed in mind and morals, as well as in body. The telegraph serves to unite peoples, and thus to awaken a larger human sympathy. It is one of the reconstructive forces in society, a practical regenerator, worth all the miracles of the saints, the "metaphysical philosophy," the Paulistic sermons, and the false teachings of physical and moral crucifixion, with which the world has been from time to time vexed, in the mad scheme to make men and society better by warring against the senses, instead of recognizing the supremacy, purity, and good sense of Nature. As such an engine of progress, the telegraph is worthy of the profoundest consideration in its moral as well as physical influences; but with its moral bearings the scope of this article will not permit us to deal as we could desire.


THE SIGNAL TELEGRAPH.


ELECTRO-MAGNETIC TELEGRAPH.

Over one hundred and eighty thousand miles of public telegraph wires are in use in the United States alone, to say nothing of private lines, which must extend several thousand miles, besides the existence of many thousand miles more of wire in use within private dwellings, hotels, etc., as signals for communications between proprietors and servants.

The interests of the entire civilized world are now affected more or less by the telegraph; and if it were not contemptible and weak to indulge anything like a "national pride," America might well be proud that her children first made practical this great mode of intercommunication, and instructed the world in its use; for the so-called "Morse telegraph" is the only one at this time in general use, and is, specially, the result of American study and labor.

The electro-magnetic telegraph structure may be succinctly described as consisting of a copper plate buried in the earth, from which extends a metallic wire to one pole of a galvanic battery. From the other pole of the battery the wire continues to one end of the helices of insulated wire which surround a core of soft iron, and from the other end back to a plate of copper corresponding with the first-named plate buried in the earth. The earth is a substitute for wire between the copper plates, and thus completes the circuit. The battery acts chemically in generating a current of galvanic electricity, which follows the wires and the earth line between the plates. This current, in passing along the helices surrounding the core of soft iron bent into the form of a horseshoe, generates magnetism in the core. An armature, or small piece of soft iron, is attached to a lever that is movable up and down upon a pivot or axis, and located in the immediate vicinity of the two ends of the iron core. This armature is attracted by the magnetization of the iron core by the current passing along the helices, and is again released from this attraction by the cessation or breaking of the galvanic current, and drawn away from the armature by a delicate spiral spring. This alternate attraction and release of the armature imparts motion back and forth to the adjacent lever; and this motion is what does the writing or imprinting of telegraphic characters upon paper kept in motion by clockwork under the rising and falling point at one end of the lever. The galvanic current passes from one end of the wire helix to the other, and thence along the route into the earth, the latter constituting the returning half of the galvanic circuit.

In the city of New York, on the 10th of June, 1871, occurred a

peculiar demonstration in honor of a great triumph of science, and of a man evidently supposed by the majority of the participants of the occasion to have wrought this great triumph, under the inspiration of a "Supreme Author," to whom the man in question saw fit to modestly attribute "the gift," as he was pleased to entitle the invention of which he discoursed. On that day, in the Central Park of New York, was unveiled a statue to the honor of Prof. Samuel B. F. Morse, by whose name the great American electro-magnetic telegraph is generally designated. In the evening of the same day a vast concourse of people met at the Academy of Music to do supplemental honors to the man. Many of the scholars and statesmen of the land were gathered together on these occasions, the honorary exercises of which were not a little poetic and sublime, and, as far as the hearts of the general participants were concerned, constitute a grand chapter in the history of the nation, as demonstrating the possession on the part of the people of that appreciative reverence which is due to science, and the exalted character of a truly great and pure man; for it would be doing too great violence to the evidence of one's senses to suppose it possible that the assembled multitudes on that day were well aware that they were only the misinformed and beguiled instruments in the hands of a number of artful men, who had called them together as the necessary stock actors in a play, which these men had designed as a means to effect certain ends of their own. The multitude assembled undoubtedly believed Prof. Morse to have been the inventor of the Electro-Magnetic Telegraph, and therefore to be entitled under the law to the letters patent therefor, which he obtained as the inventor of something "novel and useful," to the consideration shown him. It was but honorable in them, then, to pay him their homage.

But in looking over the long list of the vice-presidents of the "reception" at the Academy of Music before alluded to, the writer finds recorded the names of many eminent men, some whom it would be preposterous to suppose to have been unaware of the farcical character they were made to play, were it not for the reflection that, in this country especially, men may become "eminent," even in scientific fields, so far as the popular understanding is concerned, while quite guiltless of any scientific accomplishments or achievements. A. Oakey Hall heads the list of vice-presidents to which we allude — an eminent man on the 10th of June, 1871, and soon after rendered more eminent, and not an unfit

leader of most of the long array of those whose names follow his — the Dodges, Griswolds, Lows, Vanderbilts, Kelleys, Padelfords, and other mere merchants and politicians, whose scientific attainments and judgment need no comment. Here and there among the list are the names of sundry editors of political journals, a class of men whose " duties in life " generally forbid their aggregating to themselves anything like scientific facts, to say nothing of their lack of method in thought. Thus far the supporting array of vice-presidents was only a ludicrous phase in the farce. But in this list the writer finds incorporated the names of some who were not present on the occasion, and of whose names fraudulent and unpermitted use must have been made, inasmuch as they must have known too much of the facts regarding the origin and history of the electro-magnetic telegraph to have conscientiously allowed such use of their names.

In the light of this fact the farce assumes a serious aspect; and for the integrity of history, as well as for commemoration of the worthy living and of others — the worthy dead — to whom the world is indebted for the American electro-magnetic telegraph, it is not unfitting that we here turn to the serious consideration of the question, " Who invented this telegraph ? "

An inventor, in the legal sense, is one who discovers something "novel" to the human understanding, and "useful" to society, elementally unknown before, as in chemistry, for example; or who projects an entirely new machine, new in all its powers and parts; or who combines old and previously known forces or powers in a "novel" manner to a "useful" end. To Mr. Morse were accorded the letters patent for this invention, in the strictly legal sense considered, according to the evidence presented. With this simple fact we find no fault, and it is *prima facie* evidence that Prof. Morse is the inventor of the telegraph in question. But the letters patent by no means settle the question. These are often set aside as improperly granted. The writer regrets that his space is limited, for it would be most satisfactory to him to present in detail all the facts which bear upon the interesting question in issue, and follow the course of Prof. Morse from the year 1832, when, as he of late years has endeavored to impress the public mind, he professes to have invented the electro-magnetic telegraph, up to the 10th of June, 1871, when he allowed himself to unblushingly receive, before a vast multitude, almost divine honors, of which only the most meagre part were equitably due to him,

and no part of which were in any other than in the most strictly technical legal sense due to him; to wit, in the fact that he holds the letters patent for an invention to which, so far as it is a "novel and useful" (practical) one, he has no just claims, in the opinion of the writer.

But to follow the course of Prof. Morse would require a volume as large as the "GREAT INDUSTRIES" itself, and the writer is forced to content himself with presenting a few facts and suggestions here, leaving it to the historian, who may have abundant time and due respect to the integrity of history, to do full justice to the matter in question.

In the whole range of "pious frauds," romantic imaginings, and spurious pretences of all kinds, perhaps there never was a more ludicrous and lamentable delusion practised than that which, conducted with no mean skill at times, it must be confessed, has been practised upon the credulous masses, causing them to believe that Prof. Morse is the inventor of the practical telegraph known by his name. This delusion is the more to be regretted in that not only the masses, but large numbers of scientific and usually astute men, have been led to concur with the multitude in their error. Only now and then, it would seem, has an eminent man, even, failed to fall into this error. The writer calls to mind at the moment, however, an honorable exception, who ought to be accredited here, both as such exception and for the great skill with which, upon a delicate occasion, in embarrassing circumstances, he concealed under the most subtle irony the contempt which he must have felt for the demigod of the hour, and preserved his own self-respect, while thus avoiding also the marring of the happiness of a convivial occasion by the "sentiment:" "It is the providential distinction and splendid honor of the eminent American who is our guest to-night, that, happily prepared by previous acquirements and pursuits, he was *quick to seize the opportunity*, and give to the world the first recording telegraph. *Fortunate man! thus to link his name forever with the greatest wonder and the greatest benefit of the age.*" This gentleman was no other than the Hon. Salmon P. Chase, Chief Justice of the United States, at a dinner at Delmonico's, in New York, December 29, 1868, over which he was called to preside. Judge Chase had, many years before (1853), been engaged as attorney in a cause in which the claims of Prof. Morse were pretty thoroughly investigated. Perhaps the language of his toast, for delicate and pungent sarcasm, was never equalled.

And what were Prof. Morse's "previous acquirements and pursuits?" "Fortunate man," indeed!

Prof. Morse himself enables us to shorten our investigation for present purposes, somewhat, in that, under the fire of a cross-examination in the case of "F. O. J. Smith *vs.* Hugh Downing et al., tried before Judges Levi Woodbury, of the Supreme Court of the United States, and Hon. Peleg Sprague, of the United States district of Massachusetts, in May, 1850, he was compelled to admit that he neither "discovered electricity, galvanism, nor electro-magnetism;" nor "the electro-magnet, abstractly;" nor "the abstract fact of combining an electro-magnet generally with a circuit of conductors;" nor "that the breaking and closing of an electric or galvanic circuit, having within it a generator of electricity or galvanism, would cause an alternate flow and cessation of a current of electricity or galvanism."(!) This was not all that Prof. Morse was obliged to disclaim; but we have not space to quote extendedly from the case. He was compelled to acknowledge that he discovered nothing whatever of the elements and forces of the telegraph. But he claims that he was "the first who combined and used an electro-magnet and armature in a circuit of electric or galvanic conductors, in combination with other appliances, for a specific and novel purpose." This is the gist of his present claim; and to the initiated, the subtle character of Prof. Morse's speech on the 10th of June, at the Academy of Music, was not a little amusing. He was in a delicate position. He knew full well that there were those living who knew all about his pretensions, and it was necessary to speak guardedly; and he did so, in a style which, while it conveyed to the common mind a notion of the speaker's modest (!) but immeasurable greatness, claimed no more for him, as the intelligent and careful hearer or reader would see, than would bear inspection in the light of the case to which we have alluded above.

But let us see if Prof. Morse can sustain even the most meagre claim to the invention of the electro-magnetic telegraph, in the court of honest common sense and scientific research. The reader will remember that it is not enough to entitle one to an invention, that he has, at some time, vaguely conceived that something more or less like it might be desirable; or that he has ignorantly speculated with this or that force, and dabbled with mechanical impossibilities in order to reach a presumptive end. Millions, probably, have wished they could fly. Many have attempted to

actualize a flying machine, and all, so far, have failed. But we cannot absolutely declare that such a machine will not be invented, in the not distant future, perhaps. If a practical flying machine shall be invented, shall all the dreamers be accorded credit therefor? Or will those who have heretofore attempted to particularize certain mechanical absurdities to such end be thus honored? Neither. Prof. Morse, in the opinion of the writer, stands in relation to the electro-magnetic telegraph as a dreamer, and speculator with certain forces, to obtain the desirable end of a "recording telegraph," who never really *invented* anything important in its composition, and who never, in a practical and useful sense, "combined" any of its parts or forces. As the earnest and inefficient dreamer, he is entitled to all the credit which attaches to such a character. He got it into his head that a "telegraph," constructed in some way with wires, and over which electricity could be sent, he knew not how, would be a desirable thing. Others thought so, too, and they carried out their projects into practical operation, long before the aids of Prof. Morse developed or "invented" the "electro-magnetic telegraph." Prof. Morse did not invent the flying machine of "electro-magnetic" telegraphy. He wished that he could make such a machine, and he went to work and got together materials of which to make the wings; but he found he was unable to fashion them to any "useful" purpose. Moreover, he, in his ignorance of the then advanced state of science as to the proper forces, was unable to conceive of the motive power for the proposed wings; for the power that he selected would only lift a single feather of the wings, and not that, if it were a sufficiently long one. His efforts were, in short, all abortive; for he groped about in ignorance of both chemistry and mechanics; and according to his own story, he had spent four years in this loose dreaming and speculation, when one day a man of brains and science came along, and gave him the first scientific light which proved of importance in the realization of the object of his dreaming.

This was four years after Prof. Morse had invented, on board the Sully (as he by marked implication and almost direct statement, declared to the audience at the Academy of Music in June, 1871), the electro-magnetic telegraph. Since 1837 it has been an object with Prof. Morse to make the public believe that he invented the electro-magnetic telegraph on board the Sully, in 1832. The disingenuousness of the man on this point can best be understood by

the fact, that whereas Prof. Morse not only allowed, but encouraged, this false assumption to be entertained by his audience on that day, at the Academy of Music, he nevertheless, in his cross-examination in the case before referred to (of Smith and others *vs.* Downing and others), made oath that he "never had on board the ship, or elsewhere, any consultation with Dr. Jackson on *electro-magnetism*, in its application to telegraphing." Now, this is undoubtedly true, as circumstances subsequent to that time indicate. Yet Prof. Morse, according to his own showing, put implicit confidence in Prof. Jackson's ability to help him to a means of accomplishing a recording telegraph, and in a letter of December 7, 1837, declares, with some acrimony, that all his consultations with Dr. Jackson not only served to retard his invention, but compelled him, "after five years' delay, to consider the result of that experiment" (the one proposed on board the Sully) "as a failure, and consequently to devise a new mode of applying my apparatus — a mode entirely original with me" (Morse). Prof. Morse in the same letter says, "My invention on board the Sully is mechanical and mathematical. It has no more to do with chemical science than with geology or anatomy." (This letter was written to repudiate Dr. Jackson's claim of having instructed Prof. Morse in chemical matters relative to telegraphing.) In the case of himself and others *vs.* O'Reilly and others (known as "the Kentucky case"), Prof. Morse, on the 31st day of August, 1848, declared under oath, substantially, that he knew nothing, at the time of his invention, of the practicability of propelling electricity effectively to a great distance (in opposition to the opinion of Barlow that it was impracticable). 'He took it for granted that it was a fact, and *founded his invention upon that belief*;' but at that time he was ignorant of the fact, and of the discoverer of the fact! This shows the professor's ignorance, by his own confession, of the science of electricity at that time; and as it is clearly demonstrable that he made no progress with his invention after four years more of dreaming, it is not a violent inference to believe that he remained ignorant all that time. At any rate, we are left in no doubt about the fact that as late as the fall of 1836 he had no knowledge which could avail him practically in the construction of an electro-magnetic telegraph which would operate over the distance of forty feet. This is made evident by the statement of Prof. Lorenzo D. Gale, an intimate friend of Prof. Morse, that he (Morse) then (1836) pro-

fessed great surprise at the contents of a certain paper which Prof. Gale showed him, and which related to scientific facts, upon which Prof. Gale had just made to Prof. Morse the very "suggestions," without which the telegraph called the "Morse telegraph" could never have existed! To Prof. Gale, then, is the world directly indebted for communicating to Prof. Morse the contents of the paper in question, and showing him how his speculative and abortive machinery could be made effective, and of value for communicating intelligence to any desirable distance (though necessarily very slowly, such was the clumsy character of the "type" arrangements, etc.).

This "paper" was no less than an article by Prof. Joseph Henry, then of Princeton College, illustrating his experiments in electro-magnetism, and published in Silliman's *Journal* in the year 1831, and of which the limited scientific understanding of Prof. Morse had not permitted him to know anything before. Prof. Henry had discovered the power, and reduced it to actual practice in mechanism, which Prof. Morse, in his dreaming, longed for; and thus was Prof. Henry the legitimate father of the American electro-magnetic telegraph, in one form. But the child of Prof. Morse's dreams still needed a proper body to be of any service to the world; and here Prof. Morse's ignorance of mechanism proved another cloud too dense for his talents to pierce. He invented (with what borrowed aid we know not) some clumsy and impractical contrivances, which, however, served, with Prof. Gale's aid, to demonstrate the possibility of a successful machine some time in the future. And now came another brainful supplement to Prof. Morse's necessities, in the person of the late Mr. Alfred Vail, of Morristown, N. J. Prof. Morse showed to Mr. Vail his plan of telegraphing. Mr. Vail comprehended the mechanical condition of things at once, and saw that he could devise the right plans of machinery, if it were true that the galvanic current could be made to generate the necessary magnetic force at a distance. In a few days Mr. Vail returned, to satisfy himself as to this point; and so assuring himself, and believing in the practicability of the affair, with the right machinery, made Prof. Morse aware of his opinion. Prof. Morse soon entered into articles of agreement with Mr. Vail and Prof. Gale, whereby he not only shrewdly secured these gentlemen's aid, but bought their genius as well, binding them to give him not only their labor, but all "the improvements, new discoveries," etc., scientific and me-

chanical, which they should make." Mr. Vail went forward, and eventually invented the most important parts of the register, the lever and roller, together with the method of embossed writing, as they now exist; discovered that only one circuit of wire was necessary, instead of two, upon which Prof. Morse had insisted; and other matters, which we will not now stop to mention. In fact, Mr. Vail became the brains of the mechanical portion of the invention, and contributed to the enterprise numerous important scientific suggestions, for experiment by himself and Prof. Gale; and it is firmly believed by the writer that neither Prof. Morse nor any of his most ardent friends will undertake to prove that the professor ever made a single, however unimportant, improvement, scientific or mechanical, upon the ineffective, clumsy, and impracticable machine as Prof. Gale found it. All the improvements and subsequent new inventions were Mr. Vail's.

In the early part of his engagement with Prof. Morse, Mr. Vail provided him with the financial as well as mechanical means of making the practical experiment on a considerable scale, which was made in the iron works of the father of Mr. Vail, the late Judge Stephen Vail, at Speedwell, Morristown, N. J., in October, 1837. Mr. Vail's mechanism proved a success, and the child of Prof. Morse's confident dreams and sickly hopes was at last born, but not clothed in the beauty, and endowed with the strength, which Mr. Vail and Prof. Gale subsequently gave it. This was the American electro-magnetic telegraph, which came unexpectedly to Prof. Morse; for on board the Sully, and for four long years thereafter, he had only conceived of something,— he could not define to himself or anybody else what, and which he declared to Dr. Jackson, on December 7, 1837, had proved a failure,—but not the electro-magnetic telegraph; for he then neither knew anything of electro-magnetism, nor, of course, had any notion of what sort of machinery this force unknown to him could or would operate, in order to accomplish a recording telegraph. His flying machine now had wings, and the power to move them; and it would seem that Prof. Morse had ever since been riding on it, through the more or less sane regions in which his egotism and vanity have prompted him to move.

Mr. Alfred Vail was, at the time of his first meeting with Prof. Morse, twenty-nine years of age,—in the full vigor of manhood. Though so advanced in life, he had but just graduated with honor at the New York University. Mr. Vail, before entering college,

had been engaged in business and mechanical pursuits, and even then enjoyed the reputation of possessing great skill, mechanical ingenuity, and extensive scientific attainments. Mr. Vail was a gentleman of high and unblemished character, generous to a fault, and enthusiastic in the promotion of the telegraph, and was just such a man as would doubtless, were he living to-day, concede to Prof. Morse's arrogant claims, reserving nothing to himself of the glory of the invention. But happily the proofs of his great genius, and the part which he took in the invention of a practical American electro-magnetic telegraph, are too abundant and clear to be successfully disputed. Mr. Vail died January 18, 1859. Prof. Morse's agreement with Mr. Vail was of such a nature as to exclude Mr. Vail's taking out letters patent for his inventions. Besides, he wished to preserve the unity of the invention to the several "proprietors," who were at that time Prof. Morse, Prof. Gale, Mr. Smith, and himself, and so did not apply for letters patent.

It will be observed that Prof. Morse really invented nothing of importance in regard to the electro-magnetic telegraph, neither discovering its spirit, nor providing it with a suitable body, when brought to him by Prof. Gale. In his speech at the Academy of Music, June 10, 1871, Prof. Morse had the address to concede to Prof. Gale, Mr. Vail, and another gentleman of as much importance to him as they (the Hon. F. O. J. Smith), some recognition of their valuable services; but this concession was evidently but a part of his adroit tactics, as he who carefully reads Prof. Morse's speech in the light of this article will readily see. A monument had been that day erected, by designing and duped citizens, to the sole honor of Prof. Morse, in the Central Park of New York, and another, of a national character, to be erected at Washington, to Prof. Morse's glory, had been designed. Perhaps this fact tempted Prof. Morse to withhold their true honors from his old associates — the inventors proper of the electro-magnetic telegraph. But whatever were his temptations, his course was quite inexcusable; and though, in the language of Chief Justice Chase, he was a "fortunate man" in that he had been able to adroitly "link his name forever with the greatest wonder and the greatest benefit of the age," he ought in justice to have acknowledged more fully so than he did the merits of the men who not only enabled him to "link" his name, but pointed out the method, and provided him with the "link" itself.

We have alluded to Hon. F. O. J. Smith, to whom Prof. Morse, in his 10th of June speech, accorded the credit of early appreciating the invention. Mr. Smith was one of those men just as necessary to Prof. Morse's commercial and financial success with the telegraph, as were Prof. Gale and Mr. Vail to its invention and practical perfection. Mr. Smith, though but thirty years of age, was then serving his third term in Congress, representing the Portland district, Maine — a man of great energy, clear intellect and prevision. When, in 1838, Prof. Morse went to Washington to exhibit the telegraph, and either sell to the government the invention, or obtain aid to build an experimental line, Mr. Smith was chairman of the committee of commerce, to whose notice the matter was brought. While most of even the leading men in Congress jeered at the project of the telegraph, Mr. Smith foresaw its grand possibilities, and its great financial value, if properly handled. He brought the matter to the attention of Congress in a masterly report, and eventually entered into business relations with Prof. Morse, Prof. Gale, and Mr. Vail, regarding the telegraph; and indeed to him is due the chief credit for the skilful management by which the electro-magnetic telegraph was forced upon the attention of the people, and erected into a public necessity. Mr. Smith, though young, was even then an astute and eminent lawyer; and from what light the writer of this has upon the subject, he is led to the belief that, without Mr. Smith's counsel and assistance, the invention would neither have been secured under proper letters patent, nor preserved, even under these.

In the record of the case of Morse et al. *vs.* Smith, in the Superior Court of New York, in 1852, among other similar evidences of Mr. Smith's controlling and protecting relations to Prof. Morse, the writer finds the professor thus addressing Mr. Smith, under date New York, May 24, 1839. "I sometimes am astonished when I reflect how I have been able to take the stand, with my telegraph, in competition with European rivals, backed as they are with the purses of the kings and wealthy of their countries, while our own government leaves me to fight their battles for the honor of this invention, fettered hand and foot. *Thanks will be due to you*, not to them, *if I am able to maintain the ground occupied by the American Telegraph Company.*"

The reports of the cases in which the validity of the Morse patent was called in question, show to the mind accustomed to deal with legal subtilties, that only the most discreet management

and skill on the part of Mr. Smith could have saved the patent. The wonder is, that Mr. Smith's able opponents (some of them the first lawyers of the land) did not discover the most vulnerable points of Prof. Morse's claims. Prof. Morse may indeed be considered as one of the most "lucky" men who ever lived, finding ever at the right time the right man to act for him, and so not only succeeding in "linking his name with the greatest wonder of the age," but being enabled to keep the "linking" force unbroken, through the guardian talents of an eminent counsel, until he has achieved of wealth not enough, perhaps, and of glory not only what little is due to him, but, besides, about all that so meritedly belongs to others. But history will probably, in due time, give Prof. Morse his proper place in relation to science, and accord to Prof. Henry his true position, as well as render full honors to Prof. Gale and Mr. Vail, as the immediate inventors of the practical electro-magnetic telegraph, and to Mr. Smith his due merit for having made it a commercial success. The complete history of the electro-magnetic telegraph will, when written, be one of the most interesting of books, disclosing, as it must, the machinations of subtle minds, and many strange tergiversations, much false pretence, etc., from sources not generally suspected. It is to be hoped that it will be written while Prof. Morse is living, for it is eminently proper that he should revise those portions, especially, in which no human power but his own cunning will be able to find anything less than dubious dealing upon his part, and where that cunning will probably no longer be able to serve him. Mr. Vail, fortunately for the true history of the electro-magnetic telegraph, left a large amount of correspondence, drawings, speculative (scientific) designs, queryings, daily records, and important statements in writing, which will enable the historian to establish all the claims herein made for him, and more.

The writer of this article has designed to give nothing more than a most meagre history of the origin and growth of the electro-magnetic telegraph, and to intimate to whom the credit is due for its existence in a practical shape. That Prof. Morse may have first suggested to Dr. Jackson, on board the Sully, in 1832, the desirability of conveying intelligence by electricity, is possible. But Dr. Jackson claims the honor of the first suggestion. These gentlemen, it seems, entertain but little respect for each other's honesty, and we will not attempt to settle their dispute; for it is clear that they had no thought of the electro-magnetic telegraph

(unless Prof. Morse deliberately falsifies); and if they had not, then the telegraph proper, did *not*, as Prof. Morse declared to his audience on the 10th of June it did, have "its birth in an American ship," and was not, though he said it was, "cradled upon the ocean." But Prof. Morse is a rhetorician, as well as "inventor," and perhaps intended nothing but a "figure of speech" in this declaration. The writer's research into this matter of the invention of the telegraph has disclosed to him some very strange things, which ought to be given to the public. This is work for the patient historian to do, and it is to be hoped that it will some time be done. But enough has here been shown, it is thought, to establish the electro-magnetic or "Morse" telegraph as American in its origin and perfection, even without Morse himself (save as a sort of providential hyphen, or unwitting magnet, by which Prof. Henry's science became at last united to Mr. Vail's constructive genius).

Perhaps this article should not be brought to a conclusion without intimation to the unsuspecting reader of the object of the "artful men" (spoken of in the early part of this paper) in erecting monuments and giving ovations to Prof. Morse like that of the 10th of June. The Western Union Telegraph Company is managed by cunning men. The alleged value of its capital is about forty millions, and this cost its owners perhaps twelve per cent. thereof, or say five millions. It is anxious to induce the government to buy up its lines for forty millions, so that it may pocket thirty-five millions, and the stockholders retire each with a fortune. The company pretends to the public to be unwilling to sell, but puts Prof. Morse forward, as at the Delmonico dinner in 1868, to express *his* desire to have the nation buy the lines, hoping to create a public sentiment in favor of the government's so doing. The press is believed to be already quite extensively secured to act in the company's favor at the right time. The proceedings on the 10th of June were a part of the scheme of nationalizing the telegraph in the public sentiment, prior to urging the purchase on Congress. It might be desirable for the nation to own universal lines of telegraph. But it would be much wiser for the government to build new lines, than to purchase these old ones at a ruinous price. As the Morse patent has expired, it would be no injustice to any one if the government should build new lines.

LADIES' SHOES.

THE PROTECTIONS FOR THE FEET OF ANIMALS. — MAN MUST DEPEND ON HIS OWN INVENTION. — THE SANDAL IN ANTIQUITY. — AMONG THE JEWS. — AMONG THE ROMANS. — SHOES IN THE MIDDLE AGES. — FIRST SHOEMAKER IN THE COUNTRY. — WOMEN'S SHOES FIRST MADE IN LYNN. — THE EARLY GROWTH OF THE BUSINESS. — SHOEMAKING IMPROVED IN THIS CENTURY. — B. F. SPINNEY AND CO. — DESCRIPTION OF THEIR PROCESS. — THE CRISPINS AND THE EMPLOYERS. — HOW THEIR DISPUTES WILL BE FINALLY SETTLED.

MAN appears, in the economy of nature, to be the only animal whose feet are not protected with some defence against the injuries and friction incident to locomotion. The hoofs of the entire order of herbivorous animals — the complete protection provided for the feet of birds — shows how admirable is Nature's adaptation of means to ends. The cushioned foot of the camel, fitted to the yielding sands of the desert, and the peculiarly constructed hoofs of the mule and the mountain goat, reveal how wonderful is the contrivance which protects the brute creation from injuries which otherwise would arise to the chief organs of locomotion.

The human being, however, has no such natural provision. His feet will become hardened by use, as will his hands. Callosities will form upon the heel and ball of the foot, as they will upon any portion of the body which is subjected to the same disposing causes. Though a horse should never touch his feet to the ground, he would still have hoofs grow upon them; but a man who should pursue the same course would preserve his feet in as delicate a state as those of an infant.

In this respect, no less than for the protection of his body against cold or hunger, man is forced to depend upon his own resources; and the earliest records of antiquity show how he has displayed his ingenuity in devising suitable protection for the feet. The savage goes with his feet bare and his body naked, or nearly so;

but civilized man, guided not less by a refinement of taste than by physical necessity, exhibits his inventive genius in protecting and decorating his person.

Among the nations of antiquity sandals were first used to protect the feet. These consisted of a sole, fastened by thongs, and protecting only the bottom of the feet. They were made from a variety of materials, — wood, leather, felt, or cloth, — and were sometimes shod with iron. In Egypt palm leaves and the fibrous stalks of the papyrus were also used. Sandals varied in their form, some of them turning up in front so as to protect the toes; others covered the sides and backs of the feet, and the thongs with which they were secured displayed great skill in their arrangement, the germ, probably, of those modern devices, which, in the form of buckles, bows, and rosettes, decorate the lady's shoe of the present day.

Among the Jews the wearing of sandals was general, and, as with most nations of the East, they were worn only when walking on the rough and uneven surface of the ground, being removed on entering their dwellings. The custom of thus removing the shoes before coming into the house rendered it necessary that the shoe be so arranged as to be easily slipped upon the foot and as easily removed.

Among the Romans the art of sandal-making was carried to a high degree of perfection, and in the luxurious days of the empire the sandals worn by the women were beautifully and expensively ornamented.

During the middle ages the fashions of shoes became so extravagant and eccentric as to furnish a theme for animadversions from the pulpit, and sumptuary laws were passed in the vain hope of checking unnecessary display and wasteful expenditure. But legislation and priestly anathema were alike powerless against fashion. Mankind repel as tyrannical all attempts to interfere in matters which common sense dictates should be left to be determined by individual taste and private judgment.

The manufacture of ladies' shoes in this country began early in colonial times; and the town of Lynn, in Massachusetts, has been distinguished for this branch of industry almost from the landing of the Pilgrims, in 1620. According to Lewis's *History of Lynn*, to which we are indebted for many of the facts contained in these pages, the first shoemakers that came to Lynn were Philip Kertland and Edmund Bridges, who arrived in 1635.

In the second general letter of the governor and deputy of the New England Company, dated London, 1629, May 28, appears the following extract concerning the first shoemakers who came to Massachusetts : —

"Thomas Beard, a shoemaker, and Isack Rickman, being both recomended to vs by M^r^ Symon Whetcombe to receive their dyett and house roome at the charge of the companie, wee have agreed they shalbe w^th^ yo^u^, the Goveno^r^, or placed elsewhere, as yo^u^ shall thinke good, and receive from yo^u^, or by yo^u^ appointm^t^, their dyett and lodging, for w^ch^ they are to pay, each of them, after the rate of 10£ p. ann. And wee desire to receive a certificate, under the hand of whomsoever they shalbe soe dyetted and lodged w^th^, how long tyme they have remained w^th^ them, in case they shall otherwise dispose of themselues before the yeare bee expired, or at least wise at the end of each yeare, to the end wee may heere receive paym^t^ according to the s^d^ agreem^t^. The said Tho : Beard hath in the shipp the May Flower divers hydes, both for soles and vpp leathers, w^c^ hee intends to make vpp in botes and shoes there in the country."

Of Rickman, the other shoemaker, nothing more is known.

At first women's shoes were made in Lynn of woollen cloth, or of neats' leather only. A pair made of white silk were provided for the wedding day, and carefully preserved afterwards. About 1670 shoes with straps and buckles began to be worn, and the fashion lasted for women until about 1727. In 1750 a Welchman, named John Adam Dagyr, by the excellence of the shoes he made gave a great impetus to the business, which soon became the most important industry of the town.

The shoes were made with sharp toes and wooden heels, from half an inch to two inches high, and covered with leather. The making of the wooden heels was a separate business until about 1800, when they were discarded for the use of leather heels.

Until quite recently, shoes, both for men's and ladies' wear, were made entirely by hand, and generally by individual workmen, who worked independently of one another, instead of in "teams," as at the present day. The shoemaker's shop of the olden time deserves mention. The engraving gives a very good idea of both the exterior and interior of one of these buildings. They were generally from ten to twelve feet square, and contained from four to eight "berths," as the space occupied by each workman was called.

A SHOEMAKER'S SHOP OF THE OLDEN TIME.

Though Lynn is usually spoken of as noted for the manufacture of *ladies'* shoes, it should be borne in mind that the product of her industry includes large numbers of both misses' and children's shoes. The lasts upon which these shoes are made are numbered, or "sized," as follows: One to thirteen represent infants', children's, and part of misses' sizes; then, again, from one to seven, occasionally eight and nine, representing the largest of misses' and all of ladies' sizes. The smallest, which is taken as the basis of measurement, is about four inches in length, each size increasing about one third of an inch.

The first invention of any importance in this branch of industry was the pegging machine. Pegged shoes made by hand were manufactured in large quantities a long time before the invention of this machine; but the manufacture was, and is, confined chiefly to men's boots and shoes, and to the coarser kinds of ladies' shoes. Lynn, the great centre of the manufacture of ladies' shoes, was never engaged to any extent in the manufacture of pegged shoes. The introduction of this machine largely increased the production, and of course diminished the cost of the product.

The next great invention was the stitching machine, the product of the mechanical genius of Elias Howe. This machine was perfected in 1845, and patented in 1846. Prior to this wonderful invention ladies' shoes were "bound," as it was called, by hand. Its introduction speedily revolutionized this department of industry. A single operator with one of these machines can do the work of nearly a score working by the old process with needle and thread, rendering possible the production of the elaborately-stitched boots of the present day at moderate cost.

Hardly less important was the introdnction of the McKay sewing machine, an invention for stitching the uppers and bottoms together, thus superseding the old hand method with awl and waxed thread. These inventions, and many others of minor importance, have revolutionized this branch of industry, so that to-day the machinery employed in its prosecution represents an amount of individual labor which it would be difficult exactly to compute. In 1855 four thousand five hundred and fifteen male and eleven thousand and twenty-one female operatives, in Lynn, produced boots and shoes valued at a little upwards of four million dollars. This was before the introduction of machinery. In 1865, when but a comparatively small amount of the appliances now in use were introduced, six thousand nine hundred and eighty-four male and four

thousand eight hundred and ninety-four female operatives produced boots and shoes valued at nearly nine million dollars. In 1870 Lynn produced one hundred and eighty-seven thousand five hundred and thirty cases, of sixty pairs each, or about eleven million two hundred and fifty thousand pairs, valued at about seventeen million dollars.

The prevailing styles of ladies' boots and shoes of the present time are Polish or high-cut front-laced boots, made from cloth or leather, or a combination of both materials; button Polish, made from the same kinds of stock; Congress gaiters, or boots with elastic gores, and made mostly from cloth; slippers of leather or cloth; and, to a very limited extent, buskins, or the old-fashioned laced shoe, low cut, and made from cloth or leather.

Through the courtesy of Messrs. B. F. Spinney & Co., of Lynn, we are enabled to give an account of the several processes employed in their establishment. This firm has for several years occupied a high position, both as regards the extent of their business and the excellent quality of their productions. Messrs. Spinney & Co. have spared no expense in introducing the latest results of mechanical genius employed in this branch of industry; and their extensive and well-ordered factory may be taken as a fitting representative of the best methods now known in this important art. This firm gives employment to about two hundred male, and nearly the same number of female operatives, and in the amount of its annual production ranks among the largest houses in the trade. Entering this factory on the lower or basement floor, we found ourselves in the sole-leather department. This material, manufactured from the best slaughter hides, at New York and Pennsylvania tanneries, is first cut into strips, which determine the length of the soles. These strips are next passed through a machine which, by a system of knives, forms the soles to the necessary width. These are then "sorted" according to their quality, packed into bundles of sixty pairs each, and carried to the "stock fitting room." Here, after being wet and properly "tempered," they are run through a "splitter," which reduces them to a uniform thickness. They are then passed between rollers, which give them the firmness and solidity obtained in the old process by hammer and lapstone. They are now cut into the exact shape required, by a very ingenious machine, by which each sole is pressed upon a die by a block, which rotates by mechanism. By this movement the block makes seven hundred impressions before touching the same spot a second time. The

BOTTOMING ROOM IN FACTORY OF B. F. SPINNEY & CO., LYNN, MASS.

saving thus effected in its wear is estimated at one hundred dollars a year for each machine. With this machine a boy can prepare twenty-five cases in a day, including both outer and inner soles. The outer soles are then "channelled" by a machine which cuts the edge of the sole just below the "grain," as the hair side of the sole is termed, and leaves a groove for the stitches. They are then "moulded," or pressed to the shape of the bottom of the last by a machine, and, with the "stiffenings" or "counters" for the heels, are sent, properly labelled and numbered, to the floor above.

Upon the second floor are the offices, sales-room, trimming and packing room, and cutters' department.

The materials used for the "uppers" are goat-skins and calf-skins, and cloth, generally of the kind known as "lasting." The goat-skins are imported from Mexico, South America, and India. The calf-skins are largely of domestic production, but for the finer qualities of goods, are imported from France and Germany. The lasting is for the most part made in England. The quality of this is determined by the number of threads contained in each square inch of its upper surface. Until quite recently, the "uppers" were cut with knife and pattern; but this is now being superseded by the use of dies, which do the work with an exactness and execution impossible by the old method. The linings are made of drillings, strengthened and stayed around the tops and edges of the upper with goat-skins and sheep-skins.

The several parts of the "uppers" are now sent to the stitching-room, which occupies the entire third floor, giving accommodation to some one hundred sewing machines operated by power. Here they are pressed and basted, and then stitched together upon the sewing machines, the ornamental stitching done, and in button boots the button-holes made.

The work done in this room is performed entirely by women, under the superintendence of one foreman. Ten to fifteen different operations are performed upon the uppers in this department of the process, as the various styles may require. The uppers are now sent to the trimmers' room in the story below, where they are eyletted, if they are laced boots or shoes, by ingenious self-feeding machines, which execute this delicate process with wonderful despatch. In button boots the buttons are here sewed on, and such other operations are performed as may be necessary to complete the uppers.

At this place they are met by the soles, ready "fitted" from the stock fitting room, and uppers and bottoms are conveyed together to the bottoming department, which occupies the entire upper story of the factory, and a portion of which is shown in the engraving. The first operation here is the process of "lasting," in which the uppers are placed upon the last and tacked to the inner soles; the outer soles are now placed on, and secured with a few nails, and the tacks removed.

They are now ready for the McKay sewing machine, which will sew about five hundred pairs in a day. The channels are now cemented, and the shoes are passed to the beating-out machine. This contrivance "lays" the channels smoothly over the stitches, and subjects the soles to an immense pressure, removing all inequalities of surface, and giving the bottoms that firmness and solidity formerly obtained, under the old method, by the shoemaker's hammer. The shoes are now ready for the heels. These are first pricked or drilled with holes for the nails. This is done by a machine. They are then "loaded" by hand; that is, the nails are placed in the holes, and set in a machine worked by power. One descending stroke firmly fastens the heel to the sole. A single motion of a crank, working a semicircular knife, shaves the heel in an instant.

Another machine trims and burnishes the edges, and still another burnishes the heels. The bottoms are then scoured on sanded rollers, revolving by power, buffed and smoothed by others covered with a finer material.

The shanks are then blacked and burnished; the inner soles lined, and after being tied in pairs, are returned to the trimmers' room. Here, after being trimmed with bows, buttons, or lacings, they are packed in cartons, containing one dozen pairs each of assorted sizes. These are placed five in a case, and the goods are ready for shipment to the various markets for which they are designed.

It will be seen that a perfect system of machinery has been introduced into this department of industry, pervading every part, from the time the various materials enter the factory until they are packed, the completed product ready to be shipped to the various markets of the country.

And yet this is probably but the beginning of better things to come. The methods of a few years ago seem crude and ineffective beside those which have to-day displaced them; and these

VIEW OF LYNN, MASS., FROM FOREST PLACE.

VIEW OF LYNN, MASS., FROM SADLER'S ROCK.

again will be superseded by the more perfect products of the cunning hand and inventive brain. One great result of this is the development of skilled industry. The operator must become master of the machine whose motions he directs; and thus is developed a sense of his superiority over the mighty forces which the touch of his finger can control. Hence a consciousness of power giving self-respect and personal independence; and hence that education which is to fit him to intelligently grapple with the great questions of the day involving the true relations of capital and labor.

The Crispin organization of this and other cities and towns engaged in this industry wields a power not only from the magnitude of its numbers, but from the intrinsic importance which invests the problem, the discussion and solution of which is the great purpose of the association. The opinion is becoming more widely prevalent among those who have studied these questions, that, in the long run, the interests of capital and labor are identical, and that the chief difficulty which invests the subject is to provide a remedy for those temporary disturbances which arise from mutual misunderstandings and mutual distrust. The remedy is a work of time; and the hope of the future lies in the fact that never before was the subject so widely and so intelligently discussed as now. Statesmen, and thinkers of every class, are endeavoring to find the best answers to the industrial questions of the day; and the press spreads broadcast the ripest thoughts matured by the investigations and experiences of the past.

The Crispin organization of the city of Lynn is probably the largest in the country. In this society are found thoughtful men, who have deeply pondered the subject so nearly affecting their interests, and whose best efforts are given to adjust differences, and to establish harmonious relations between the employer and the employed.

These endeavors are met, on the part of the manufacturers, in a spirit of conciliation which has established a degree of confidence and good will that is truly surprising, when we consider the different stand-points from which each regards the apparently conflicting interests involved in the great questions at issue. May these harmonious relations continue to exist.

The history of the branch of industry, considered in this article, is invested with a peculiar and almost romantic interest, from the fact that the entire revolution in its modes of manufacture, from the irregular and unsystematic methods of hand-work to its

present complete factory system, has taken place within the past ten years, the McKay sewing machine, which was the pioneer in this great change, having been introduced in the year 1861, and first employed upon the coarse work of "army brogans." It was speedily adapted to the finer work in ladies' shoes, and supplying the needs created by this great invention, one machine after another has followed, until the present grand result has been attained.

It is a very significant fact, bearing upon this matter, that very generally the most successful manufacturing houses engaged in this trade, are composed of men under middle age, who have entered the business since the "new departure" in the manufacture of shoes. The history of the firm whose business has supplied the foregoing description deserves mention in this connection. Mr. B. F. Spinney, the leading member of the firm, and who established the business, is a young man, being, we should judge from his appearance, about thirty-five years of age. He came to Lynn in 1858, now thirteen years ago, and located his business on Willow Street, associating with himself Mr. G. N. Spinney, under the firm name of B. F. & G. N. Spinney. Subsequently, the last named gentleman retired, and for a few years the business was conducted by Mr. B. F. Spinney alone. More recently Mr. Ivers L. Witherell, who is thoroughly informed in all the practical details of manufacturing shoes, became connected with the business.

The rapidly rising reputation of the house, the popularity of the style of goods it was enabled to put upon the market, the confidence it inspired throughout the trade, and the energy manifested by its managers, soon made a change of location needful in order to secure greater facilities for meeting the demands of a constantly increasing business. Accordingly, the present extensive and convenient factory was erected on Union Street, and the business transferred to it in the year 1864. This factory, as has been shown, is thoroughly furnished with all modern facilities for manufacturing shoes. The enterprise and intelligence of the management have always prompted a timely adoption of the best methods in this line of business. And one needs but to visit, as we have done, the varied and extensive departments of the establishment, ascend from basement to upper floor, and note the different successive stages through which a shoe is obliged to pass, in order to be convinced of the thorough system and efficiency that Messrs. Spinney & Co. have introduced into their business.

The mechanical appliances are not only the best and most complete known in the manufacture of shoes, but one can see at a glance, that the persons representing the different departments of the work manifest the intelligence that bespeaks the highest capacity in producing the best results of the labor under their control. By a natural wisdom and a shrewd judgment of human nature, this establishment has succeeded in drawing about it the most skilful labor in the craft of "St. Crispin." This fact is evinced by the well-known standing of its goods throughout the trade.

There is one thing we feel called upon to say in contemplating the course of this house — it has never been willing to sacrifice its reputation for manufacturing a line of first-class goods, that will bear the most rigid tests, in obedience to the clamor for a cheap and common article of wear. It has valued more a permanent reputation for durability and taste, than the temporary triumph of depreciated products which are now so extensively placed upon the market.

This fact explains why this establishment commands the patronage of so many of the best shoe houses in our large cities. It is reliable and straightforward in its business methods, depends upon the merits of its goods; is not fickle and sensational in its style, and therefore wins its patrons into permanent customers.

The modern demand for "shoddy" has not broken down its faith in the sound maxim of business that a good article at a fair price is better than a poor one at more than it is worth. At the same time such are the financial resources of the firm, its advantages in purchasing stock, its system of trained and skilful labor, and the extent of its operations in this branch of industry, that it has been able to put into the shoe markets of the country the very best qualities of goods at the most reasonable prices; thus demonstrating that it is possible to hold a reputation for first class goods that will secure the confidence of the buyer, and at the same time to furnish them at prices that will compel his patronage.

Messrs. Spinney & Co., making a speciality in their factory of ladies' wear, and being determined that that speciality shall hold the highest position in the market, may take some pleasure in reflecting that their original purpose, so uniformly sustained, has brought them reputation and success.

The writer of this sketch is familiar with the leading shoe houses in the large business centres of the country; and in the great West

particularly, where this well-known firm finds its principal market, the quality of its goods commands the highest confidence. It stands as an example, in this day when elegance and variety in the make-up of shoes are so marvellous, of the lightness, grace, and beauty of the "fine art" of protecting and decorating the foot.

We predict for this well-established business a future of greater success, even, than has characterized its past. The introduction of steam and machinery makes extension of labor wonderfully practicable. Past success will be but a stepping-stone to future efforts. Skill and energy will prompt to larger plans, and if we do not mistake, we shall still find the establishment, whose courtesy enabled us to give the facts of this article, holding a leading place among the shoe manufacturers of the "City of Soles."

WOOD TYPE.

GUTENBERG AND HIS ART. — THE CHINESE IN RELATION TO PRINTING. — THE ART OF WOOD-TYPE FACTURE AT THE PRESENT TIME. — THE LEADING MANUFACTURERS IN THE UNITED STATES, MESSRS. WILLIAM H. PAGE AND COMPANY, OF GREENVILLE, CONN. — OF MR. PAGE. — THE ESTABLISHMENT AT GREENVILLE. — THE PROCESS OF MANUFACTURE. — THE MACHINERY EMPLOYED.

WHEN Gutenberg first conceived of his famous types, which have revolutionized the world, he could hardly have dreamed of a spirit like that of American enterprise, which was to arise in the then far future, and demand of one type in the nineteenth century more extent of execution, — that is, of ink-spreading, — than he with his clumsy types could safely attempt with a whole font. But Gutenberg lived in the fifteenth century, and it was somewhere about the year 1435 that he invented his wonderful symbols. With all its wars among nations, the world was, notwithstanding, a peaceable planet then in comparison with the hubbub and noise which extended commerce and the intellectual conflicts which science have now everywhere inspired. What would Gutenberg have thought of that printing art which demands for the construction of a single letter one hundred and sixty feet of lumber, while at the same time it makes use of small types in countless profusion almost as numberless as the sands on the sea-shore?

But back of Gutenberg, as far as the year 900, — if we are to credit plausible testimony, — that wonderful people, the Chinese, made printed impressions from engraved wooden blocks; and it may be that in their ages of experience they may have come to need, and learned to make, letters both larger and smaller than Yankee ingenuity has devised. Far in advance of us miserable Westerners, the Orientals had the good sense, centuries ago, to know that a paper currency is preferable to a metallic one, and therefore "made paper money" then, like the sensible people they are,

masters of the world's best political economy. And since we foreigners are not permitted to inspect Chinese workshops and studios of art, we are ignorant as to whether they accomplish in wood type the greatest possible successes. But regarding Europe and this country, we are not left in doubt as to the representative manufactures of wood type, — an art which has revived in latter years, after a comparative obscuration by metal type for centuries, and become one of the greatest importance. This fact is due, for the most part, to the advertising enterprise in the United States, which will not be satisfied with modest display, but must express itself in the largest as well as most fanciful posters, etc., for the construction of which metal type are quite out of the question.

Wood type have, since the early days of printing, been made to some extent; but it was not before the year 1827 that its manufacture became anything like a special and regular business, even on a small scale. In that year Mr. Darius Wells, a printer in New York, cut several fonts of wood type for his own use, which proved so much superior to the wood type then sparsely in use, that he was induced to turn his attention to the manufacture of this order of type as a distinct business. His tools, patterns, and processes were, as a natural incident of a business in its crude state, very rude and unskilful, in comparison to those existing today in the factory of the leading manufacturers of wood type, the Messrs. William H. Page & Co., of Greenville, Conn.

About the time that Mr. Wells entered upon the business, a Mr. Edwin Allen, of South Windham, Conn., also embarked in it, and continued it for many years, his business eventually becoming incorporated in that of Messrs. Page & Co. Indeed, the principle of the chief machines used by Mr. Allen is still preserved, though with many improvements in the construction of the instruments in the machines now operated by Messrs. Page & Co. The business made fair progress under the control of Mr. Allen; and a very respectable business was also conducted by Darius Wells & Co., at Paterson, N. J.; but the business was of a peculiar nature, requiring for its conduct, not only that order of business talent which judiciously supplies an existing demand, but also the forecasting and planning genius which creates a demand commensurate with the ability to respond to it. Finally, the man combining the requisite talents appeared in the person of Mr. William H. Page, the founder and principal of the house of William H. Page & Co., to whom we have before alluded.

The biographies of men who, like Mr. Page, make their distinctive mark in the promotion of a great industry, or an elegant art, are never without interest to the general public; and that of Mr. Page may properly be dwelt upon in a work of this kind in a cursory manner. Mr. Page was born in New Hampshire, in 1829, and began his business career in a "country printing office" at the age of fourteen. He continued to follow, as apprentice and "jour," the profession of a type-setter for some sixteen years in different cities of New York and New England, and finally made his way to Norwich, Conn., where he was induced by a friend to turn his attention to the matter of manufacturing wood type. With a ready grasp of the situation, Mr. Page's inventive mind foresaw what the future might have in store for him, if the proper business conditions could be controlled. Quite proficient in landscape painting and designing, he had an intellectual turn of mind, and disciplined by having employed his leisure hours in sundry studies which he could now make available, he set himself with confidence to work out the problem of a large and honorable business from the fragmentary elements which he found at hand. It was in the fall of 1854 that, with no one to instruct him, he began the work of a type-trimmer or finisher. His judgment was his only guide. What machinery he had was poor.

For about two years matters progressed slowly and unsatisfactorily, and Mr. Page came to the conclusion that only by greatly improved machinery could the proper finishing be profitably given to the type. His first step was to procure the machinery of a wood-type establishment which had failed several years before, and with courage and genius as his capital, and with the responsibilities of a "master of a household" upon his shoulders,—for he had just then married,—he started a factory on his own account at South Windham, Conn. This was in 1856. During the next year many improvements were made in his machinery, and a much superior kind of type produced. 1857 was a year of financial disasters, and nothing but the artistic merit of Mr. Page's type could have saved him from being wrecked with the many business houses which then went down. But the business survived in a healthy state, and in the fall of that year was removed to Greenville, Conn., where extensive quarters were secured; and soon finding that the demand for his wares, the improved kinds which he had meanwhile devised, required the addition of more extensive improvements in machinery, and a larger capital than he then possessed, Mr. Page entered

into partnership with Mr. Samuel Mowry, a wealthy capitalist and experienced business man, of Greenville. Extensive additions were then made to the machinery of the establishment; but such has been the steady march of improvement therein that it is only within the past four or five years that Mr. Page's excellent machinery can be said to have become perfected. This is now unequalled for its purpose in the whole field of mechanics; and the type of this firm is universally acknowledged to be the best in use. Indeed, Messrs. Page & Co. may be said to control the market for wood type, and to be virtually without competition.

The factory of Messrs. William H. Page & Co. is situated on the banks of the Shetucket River, and utilizes a water power of incalculable value to a manufacturing interest. This firm not only possess the facilities for carrying on their extensive business, but are prepared to meet any increasing demands the business may require in coming years. This establishment gives employment to a large number of hands, a goodly portion of whom are females, who exhibit great skill in the manipulation of the deft and delicate machinery.

The principal material used in the manufacture of wood type is hard maple, and for the purposes of this establishment is mostly selected on the Connecticut hills, near to and far from the factory, by Mr. Page himself, and is brought in logs to the factory. These are first sawn in cuts across their diameter, then steamed, and subsequently packed away in a drying room for fully two years before they are made up into type. The blocks are then dressed very smooth by hand, and planed to type height by machinery, every piece being gauged, to insure the utmost accuracy. The upper surface is then twice lacquered and also twice sandpapered, leaving it in a perfectly smooth and polished condition. They are then sawed into pieces of the requisite size for the letters required, and the most interesting feature of the work begins. Wood letters for posters and general printing are made from the size of two-line pica, or one third of an inch, up to about twenty inches, by machinery, and cut partly by hand, from the latter size up to the largest thus far made, which requires a hundred and sixty feet of lumber per letter!

The machine for cutting the type from a pattern is a most ingenious contrivance, and of such a nature as to be almost impossible to describe or explain without diagrams. The whole thing being made of cast iron and steel, the movable part resting on a

WOOD TYPE AND BORDER CUT BY MACHINERY. W. H. PAGE & CO, GREENVILLE, CONN.

large cast-iron table, the pattern is fastened in at one point, while the block for the letter is fastened at another. A tracer at one corner of the machine is made to follow the pattern, while the cutter at another point cuts the letter. The cutter makes from eighteen to twenty thousand revolutions per minute. As the machine is adjustable, a number of sizes can be cut from the same pattern. A difficulty is here experienced in making borders for two colors in wood. After one lot is made, and the machine altered or changed to a different size, it is almost impossible to reset it so that a continuation of the same border would match the first one cut. When the letters are taken from the machines, they go into the hands of the type-trimmer, where the best of skilled workmanship is required to give them the finishing touches, then soaked in oil, and put up in packages of convenient lengths for boxing.

There are also several machines for the preparation of various other styles of wood-cutting, a most successful feature being the elegance achieved in the cutting of tint-blocks for envelopes and other purposes. The lines on these blocks are cut so exceedingly fine and delicate that it becomes a matter of wonder that it is possible to print from them without the ink at once filling the surface of the block; yet some of the choicest specimens of press-work that we are familiar with have been done from these same wooden tint-blocks. The type-cutting machines are quite expensive affairs, some of those used by Messrs. Page & Co. having cost in the neighborhood of one thousand dollars to build.

The accompanying full-page engraving illustrates some of the exquisite wood-type workmanship of Messrs. William H. Page & Co. It will be observed that the art is specifically confined to the letters of the alphabet, but .includes rules, borders, etc., connected with the printing business.

CARRIAGE AXLES AND SPRINGS.

OLD-TIME CHARIOTS. — SOLOMON LACKING IN INVENTIVE GENIUS. — SPRINGLESS VEHICLES IN QUEEN ELIZABETH'S TIME. — THE AXLE AND SPRING MANUFACTURE IN THE UNITED STATES. — THE LEADING MANUFACTORY THAT OF THE MOWRY AXLE AND MACHINE COMPANY, OF GREENVILLE, CONN. — PROCESSES OF MANUFACTURE. — VARIOUS IMPORTANT MACHINES MANUFACTURED BY THIS COMPANY. — THE REED AND BOWEN COMBINATION SHEAR AND PUNCH. — THE SIBLEY SELF-OILER JOURNAL-BOX. — THE WEST TIRE-SETTER, A MARVEL OF MECHANICS. — THE SIBLEY PHOTOGRAPH PRESS. — PAPER ENGINES, ETC.

Perhaps nothing in the history of human progress is more marked than are modern improvements in vehicles of transportation, especially those adapted to the conveyance of persons. And among these improvements none are more important than those which have been effected in axletrees, and by the invention of various springs, to make the coach, wagon, or whatever the vehicle may be, more comfortable to its occupant.

Chariots, or two-wheeled vehicles, always clumsy in their moving parts, and made tolerable to the eye only by the graceful shape of their upper, or box work, existed in the earliest historic periods. These were mostly used by kings and grandees on state occasions, or by soldiers in battle, sometimes having scythes and crooked knives affixed to their axles. When Pharaoh set Joseph over Egypt, he "made him to ride in the second chariot which he had" (*Gen.* xli. 43), which, though a nominal honor, must have been a sort of "cross" for poor Joseph to bear, inasmuch as without springs the clumsy chariot could hardly have been equal for ease to a modern lumber-box wagon. Solomon did more or less business in the chariot line, as is evident from 1 *Kings* x. 29. The business was probably a profitable one, as those poor vehicles sold for six hundred shekels, or about three hundred and seventy-five dollars of our money. In reading of these clumsy affairs in the Scriptures, and reflecting upon Solomon's having been a man of

superior wisdom, one is led to wonder that some improvements in these vehicles were not made by him. He ought at least to have displayed the small modicum of genius which it requires to invent carriage springs of a poor kind. But the history of man shows that talent and genius have been distributed along down the line of the ages among men with a sort of parsimony on the part of Nature, as if the good dame's gifts, or source of the same, were limited. Perhaps it is; and this would account for Solomon's stupidity in persisting in riding in, and dealing in, lumber-box chariots, constructed with bungling axles.

The Greeks and Romans used chariots to some extent, but the general use of these or other wheeled vehicles was impossible in early times on account of the want of suitable roads. Even till after the middle ages, during which riding was principally done on horseback, carriages were uncommon, so much so that one of an indifferent and uncomely structure was thought fit to be mentioned in history, if it chanced on occasion to bear a king. Even in 1550 there were only three coaches to be found in Paris, then a distinguished city. Coaches were introduced into England in 1554, the first by a Dutchman, for Queen Elizabeth's use. Soon after "divers great ladies," in jealousy of the queen, caused coaches to be made for themselves, to ride up and down the country in; and after a period of a quarter of a century the coach-making trade obtained some foothold in England.

In the early settlement of this country nothing better than the common ox-cart, or the most cumbersome wooden-axle lumber-box wagon was known up to a comparatively recent date. In the early part of this century the greatest advance made in carriages was the adaptation to some of the leathern side-spring. To the introduction and perfection of the iron axle and the best class of steel springs, permitting lightness of structure, is due the present elegance of our wagons and carriages, which have no equals in the world. The traveller from this country to Europe is at once struck with the comparative cumbersomeness and inelegance of European vehicles.

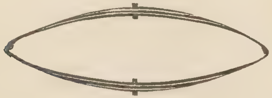
The axle and spring manufacture in this country constitutes a large business interest, employing a great amount of capital and a large number of hands in various parts of the land. The representative establishment of the United States in the manufacture of springs and axles, both in the matter of quality and in that of quantity as regards the perfectly finished kinds of the same, is that

of The Mowry Axle and Machine Company, of Greenville, Conn., who make all kinds of axles and springs, from the lightest and most tasteful, such as we use in trotting sulkies, to the heaviest, for omnibuses, for example. The business of this company was established in 1845 by Mr. Samuel Mowry, then a man in middle life, and a pioneer of cotton manufacturing in this country, and who had accumulated a large estate, enabling him to at once enter upon the axle and spring business with every advantage and facility which the state of the art then permitted, taking at once the leading position, which the establishment has continued to hold. The business was conducted under the firm name of Samuel Mowry & Sons till 1869, when it was incorporated under the style of "The Mowry Axle and Machine Company."

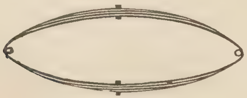
At this establishment in the manufacture of axles only the best Salisbury iron is used, brought to the factory directly from the mill in bars. It is first cut into proper lengths by immense shears heated to a red heat, and drawn out under trip-hammers. The collar of the axle is formed in dies, as well as the "arm," that portion on which the wheel runs. The arm is then turned to the right size, and receives whatever grooves are necessary in its construction, and is then "steel-converted," as to its surface, to the depth of about one sixteenth or an eighth of an inch, the surface becoming so hard that a file will make no impression upon it. The process of steel-converting is this: Hollow boxes or cylinders of cast iron, twice as large, perhaps, as an axle arm, are filled with bone dust and other materials containing carbon, and into these the axle arms are thrust, and, thus covered, placed in a fire made of charcoal, and of intense heat. The bone dust, etc., become speedily calcined, parting with their carbon, which is imparted directly to the red-heated arms, converting the surfaces of the same into steel. The arms are taken from this fire when at a red heat, denuded of the boxes, and plunged into a cold bath, hardening them to such a degree that no amount of friction, even that of grindstones or emery wheels, produces any effect upon them. Hence it is necessary that they be duly polished and finished, having the thread cut upon their ends, etc., before being subjected to this process. Salisbury iron is the most tough and tenacious iron in use, and therefore the best for these axles. All the axles of this company are brought to given sizes by a gauge, so that all axles of a certain size could run in the same box, and may be interchanged.

CONCORD SIDE SPRING.

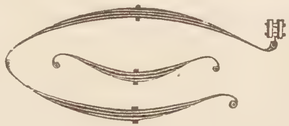
BOW SHAPED SIDE SPRING.



FRENCH ELLIPTIC.



ELLIPTIC COMMON HEAD.



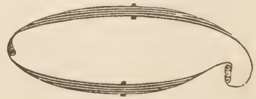
FRENCH PLATFORM AND CROSS.

SCROLL PLATFORM AND CROSS.

CONCORD SHORT SHANK.

IMPROVED TAPER SHORT SHANK.

PHILADELPHIA SHAPE.



SCROLL.

HALF PATENT FANTAIL.

MAIL COACH AXLE, LONG SHANK.

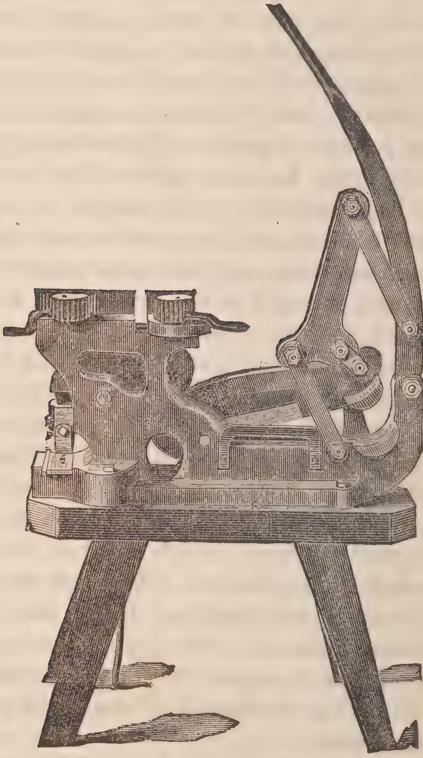
SPRINGS AND AXLES MANUFACTURED BY THE MOWRY AXLE AND MACHINE COMPANY, GREENEVILLE, CONN.

The nuts attached to these axles are made of a peculiar composition, and the boxes of cast iron lined with the same. Constructed of this, the boxes are far more durable than if made of iron. Most of the improvements which have been made in axles in the last quarter of a century have originated at this establishment. Perhaps the most noticeable of them is the leaving of a small shoulder on the arm at the point where it unites with the collar. When the arm is cut down so that its line at that point forms a right angle with the collar, the axle is liable to break there. Oil and dirt gather at that point, and by the tremor of the axle when in running use are made to cut into the axle at the collar joint, and so weaken the axle there. Had this house secured the improvement by letters patent, instead of generously abandoning it to the public, this item alone would have brought to them a vast fortune in addition to their large capital. As an example of the perfect axle work of this establishment, the fact may be mentioned that, after ten years' constant use, these axles are found to bear the impression of the makers' name, stamped on the arm before being steel-converted, as clear and distinct as when first placed in use, and this at points where the whole weight of the vehicle or loads are felt.

The carriage springs of The Mowry Axle and Machine Company are unequalled for finish, elasticity, and durability. These are made of the best English or Swedes steel. When the business was commenced by this house, springs were but little in use. Several manufacturers, in attempting to establish the business, had failed. English steel was used, which was not then good. The steel-makers made it of English iron, which was then not so durable as now. Many years transpired before steel springs were brought to the durable and economical point, and great credit is due to Mr. Samuel Mowry, especially, for the genius and industry which he used in putting the facture of steel springs in this country on a permanent basis.

The steel comes to the factory in bars, which are cut into required lengths. The ends of those intended for the "backs," or the longest parts which are attached to each other by "heads," are heated to red heat, and the heads, first struck out into the right shape from Swedes iron, are welded on under a power-hammer, which "forms" the head. These heads are uniform in shape, so that they will all, of a given size, apply to backs of a certain size. This method of heading is a very great improvement over the common process, and is an invention of great value.

The several plates of the springs are rolled from their centres, gradually thinning to their ends, where they present a sharp edge under a gauge, so that the spring when made presents on its surface a perfectly regular declension in thickness from the centre to the ends of the backs, where the latter are united to the heads. There are many advantages in springs thus made, both as regards elasticity and durability, as well as elegance. The workman first



REED AND BOWEN PUNCH.

shapes out the backs to suit his pattern, and then adjusts each plate to it. When otherwise finished the spring is tempered in oil. No spring is allowed to leave the establishment till it has undergone the most thorough tests. Having won their high reputation by extreme care in the manufacture of their wares, this house continues to preserve it by the same means.

Aside from its axles and springs, this establishment is worthy of

comment here in the fact that it controls the manufacture of several most important machines for working in iron. Among these we have selected three for especial mention, one of them being the so-called " Reed and Bowen Punch " (a cut of which we here give, and which will better describe the machine than can mere words), for blacksmiths' and carriage smiths' use; another being " Sibley's Self-oiler Journal Box," which we will describe farther on; and the third being one of the most marvellous inventions ever made in mechanics, and known as " West's American Tire-setter," representations of which accompany this article on the annexed page of cuts. The punch is of immense power, and comprises in its construction a pair of shears. Its combination of levers, four in number, is such that, with 100 lbs. power on the lever, a pressure of more than 70,000 lbs. is given to the punch proper, and more than 52,000 lbs. to the shears. The whole machine weighs but 350 lbs. On the top of the machine, where two wheels, like, with handles, are observed attached, two ends of a tire, for example, may be placed, held by these notched wheels, and be thoroughly "upset" with one motion of the lever, rendering cutting and welding entirely unnecessary; and a perfect circle of any size can be formed by placing an iron bar in a " bender " at the end of the shears. By this machine saws are gummed with a freedom and celerity never obtained by any other machine. Only one man is required to work the machine. This punch has already acquired the reputation among first-class manufactures due to its great merits.

The Sibley self-oiler journal box is a specimen of perfect mechanism. It is the invention of Mr. Rufus Sibley, the superintendent of the establishment. The journal box may be fixed on a stand or suspended in "hangers." The journal box is united with the improved hanger by bolt and check-nuts, and is so constructed externally as to adapt itself, being hung on trunnions, to any up-and-down or lateral motion of the shaft, fulfilling perfectly in this regard the long-felt desideratum. It is constructed in two pieces, a base and cap fitting to each other. Within, in each part, is cut half of an oil-chamber; within this chamber, and affixed by a screw to the shaft, is an iron ring with a small scoop attached to it, and which revolves with the shaft, the scoop at every revolution dipping up the oil from the chamber and carrying it upward so as to constantly lubricate the shaft. A groove is made in either end of the base leading to the oil-chamber, through which whatever oil

The Mowry Axle and Machine Company are also sole manufacturers of Sibley's Photograph Press, which may be described as an inverted car working within a frame on four wheels, which are so connected with the roller by which the picture is rolled as to move along with it, thus preventing the card from "curling," and obviating the artistic deformity which always follows the use of the rollers, by the elongation of the picture which they produce. Good pictures are thus usually spoiled. This establishment also manufactures paper engines, rag boilers, and all the machinery connected with paper-making, up to the Fourdrinier machine.

The Mowry Axle and Machine Company will be seen by the above to be, not only the leading manufacturers of carriage axles and springs in this country, but peculiarly alive to the promotion of excellent machinery of various kinds.

PINS.

HISTORY OF THE MANUFACTURE OF PINS UP TO THE PERIOD OF THE REVOLUTION. — THE MANUFACTURE IN THIS COUNTRY. — DR. J. I. HOWE'S INVENTIONS FOR THE MAKING OF PINS.

Among the various articles for personal use which modern ingenuity provides for our convenience, there is not one which adds more to our comfort than the bountiful supply of pins, which are provided in such quantities by the aid of machinery and organized industry as practically to place them within the reach of every one. The first suggestion of a pin was unquestionably furnished to our uncivilized ancestors by the thorns which various plants bear; and among the nations of antiquity, who had arrived at the arts of working metals, various substitutes were made for these useful little articles. Even up to quite modern times, pins, as we now have them, were unknown, and until the sixteenth century the poor were obliged to make use of strings and other makeshifts, while the rich, even the ladies of the royal families, used ribbons, clasps, or skewers made of gold, silver, brass, ivory, bone, or wood. In England pins were first introduced from France, in 1543. In this country wire-drawing, upon which the manufacture of pins depends, was first introduced in the Plymouth Colony. In October, 1666, Nathaniel Robbinson, "wyer-drawer," petitioned the General Court for aid in establishing the business. The court, however, did not grant his request. In the same month of the next year Joseph Jenks, Sr., desired "the favor of the court to advance a sume for y^e encouragement of wyer-drawing," etc. The court, in reply, thought it "not meet to advance any money on that design; but being desirous to encourage all persons among us in manuall arts and trade of publicque vtilitye, and being informed that there are in this towne a sett of tooles for wyer-drawing, and that there be some in this place that are able and skillful in that

imploy, the improovement whereof would be of great use in sundry respects, this court doth therefore order the Treasurer of the county to disburse out of the public treasury such a sume of money as will be necessary for the purchase of the said instruments and tooles, not exceeding fifteen pounds ; and the Treasurer and Mayor-Generall Leveret are appointed and empowered to dispose of the said instruments so as may best further the ends proposed, as also to disburse forty shillings for the encouragement of those that shall make cards and pinns of the said wiar."

Of the growth of this proposed industry nothing more appears from the records. The next notice we find of the business during the colonial times appears in the *History of Rhode Island*. During the revolution pins were made at Cumberland by Jeremiah Wilkinson, who drew the wire himself for their manufacture. Up to this time the heads of pins were made of a fine wire, twisted firmly about the top of the body of the pin ; and during the same contest Samuel Slocum, of Rhode Island, who some twenty-five years before had patented a machine for making solid-headed pins in England, introduced a machine for making them in this country, and commenced their manufacture in Providence. In 1775 Leonard Chester, of Wethersfield, Conn., proposed to the legislature of the state to erect a pin factory in that town ; and a few years later Dr. Apollos Hinsley, of Connecticut, who was a fertile inventor, invented a machine for making pins. In 1775 the convention which assembled at Newbern, N. C., on the 3d of April, resolved, "from common prudence and regard for the colony, to encourage, both by their influence and by pecuniary rewards, the arts, manufactures, and agriculture of the colony;" and the Provincial Congress of the state, in the fall of the same year, followed the same course, and, among other measures, offered fifty pounds for the first twenty-five dozen pins of domestic make, equal to those imported from England, and costing seven shillings and sixpence a dozen. This will give us an idea of the scarcity and the cost of pins in this country just prior to, and during, the revolution.

Through various struggles, the manufacture of pins has in these times grown to be a very important art in this country. Probably as good pins as any made in the world are manufactured here.

In 1831 Dr. J. I. Howe, then of New York, succeeded in inventing a machine for making pins, which did very good work, and made pins at one operation. The next year a company was formed for the manufacture of Dr. Howe's machine.

In 1835 another company was formed for making pins by machinery, which continued its operations under the charge of Dr. Howe until 1865. Meanwhile Dr. Howe invented several improvements of great importance in his machines, among them (in 1838) the "rotary" machine. But this has been materially improved in subsequent times. These machines make the solid-headed pin. As a necessary adjunct to the pin-making machine, came finally the pin-sticking machine, which was invented by Samuel Slocum, and patented by him in 1841. Dr. Howe invented an important improvement in machine pin-stickers, which was patented in 1843; and he and Mr. Slocum eventually became joint owners of the two patents. From that time on, the pin-making business steadily increased to its now large proportions. The chief establishments for the manufacture of pins are situated in Birmingham, Waterbury, and Winsted, Conn.

QUARRIES.

FIRST GRANITE USED IN THE UNITED STATES. — OLD FOUNDATIONS AND WALLS. — THE QUINCY GRANITE. — FIRST RAILROAD IN THE COUNTRY. — THE GRANITE HILLS OF NEW ENGLAND. — THE ASTOR HOUSE AND OTHER GREAT GRANITE BUILDINGS. — HOW GRANITE IS QUARRIED. — PAVING STONES. — AMERICAN MARBLES. — THE STATUARY MARBLES OF VERMONT. — VARIEGATED MARBLES IN VARIOUS STATES. — THE CAPITOL AT WASHINGTON. — SERPENTINE AND VERD ANTIQUE. — WESTCHESTER AND SING SING STONE.— EXTENT OF IMPORT, EXPORT, AND MANUFACTURE OF MARBLE IN THE UNITED STATES. — BROWN FREESTONE. — THE PORTLAND QUARRIES. — NEW JERSEY STONE. — HUDSON RIVER FLAGGING AND CURBING STONE. — QUARRIES THROUGHOUT THE COUNTRY. — SLATE QUARRIES. — GRINDSTONES AND MILLSTONES.

Although the early colonists of Massachusetts found, or could have found, abundant supplies of slate, stone, clay for bricks, and other durable building material, yet for more than a century wood was almost universally used. In 1657 in such buildings in Boston as, according to the description, were "fairly set forth with brick, tile, slate, and stone," these materials were imported. A single building (King's Chapel) was built of the Braintree granite, in 1752, the first granite used in the country. The Dutch of New York, who imported the yellow brick from Holland, put stone on the free list, in 1648, to encourage its introduction from abroad, when literal "free stone" might have been had for the quarrying close by in New Jersey.

The foundations still standing of old wooden buildings erected in the last century show that the early settlers made use of such surface stone as were readily procurable for this purpose, the rocks in the fields and on the hill-sides furnishing the supply, while the smaller pieces were used in the stone-wall boundaries of farms and fields. The extensive quarrying of the Quincy, Mass., granite began early in the present century, and the first railroad in the country was built from these quarries, three miles to the Neponset

River, in 1827. It was a horse railroad, exclusively for the transportation of this stone for shipment.

All New England abounds in granite, which is also found in the highlands of the Hudson River, on Staten Island, on Delaware Bay, in South Carolina, in Georgia, in California, and in a few other states. There are very superior quarries on the coast of Maine, which have the advantage of easy shipment, while the stone is fully equal to that of Massachusetts. For hardness and durability the Quincy granite is most esteemed. It is seen in many buildings in the large cities on the Atlantic coast, and has been exported to the West Indies. Notable buildings of this stone are the Merchants' Exchange (now used as a Custom House) and the Astor House in New York, and the Custom House in New Orleans. Enormous blocks for pillars, weighing many tons, have been got out in these quarries, and the stone for many buildings have been cut, finished, and numbered at the quarries in readiness for laying in their proper place in the building, which may be hundreds of miles away. The granite is quarried by drilling holes to a small depth in the face of the rock, into which small steel wedges are inserted and driven, and the blocks of almost any size are thus split off. The granite of Staten Island, and of Weehawken, N. J., is much denser than the Quincy stone, and has been largely used in the Russ and Belgian pavement in New York and in other cities.

Limestone and white marbles are plentiful in the United States, particularly in Vermont, Western Massachusetts, New York, Pennsylvania, Maryland, the Carolinas, Georgia, and Alabama. American marbles were first used in making busts in Philadelphia, in 1804. The Rutland, Vt., quarries now supply statuary marbles, which, in whiteness, texture, and purity, equal the celebrated marble of Carrara. Several of the statues designed for the interior of the Capitol at Washington are from this marble. The working of the Vermont quarries to any extent is of comparatively recent date. In 1834 a factory, with one hundred and fifty saws, was established at Black River, in Plymouth, Vt., for the manufacture of marble from white and variegated limestone. Some of the finest American variegated marbles are taken from quarries in the north of Vermont, near Lake Champlain. Gray and clouded limestones, quarried in Maine, are much used for marble mantels. California produces a brilliant red and brown variegated marble, which can be highly polished, and is much used for ornamental

purposes. The Potomac River quarries turn out brecciated marbles. The Knoxville, Tenn., red marbles have been considerably used in the interior of the Capitol extensions at Washington, and in other government buildings. Very handsome fossiliferous marbles, containing petrified shells, have been found in different parts of the United States.

Serpentine and verd antique marble quarries were worked fifty years ago in Connecticut, and they are found in most of the New England states, and in various parts of New York and Pennsylvania.

Of the white marbles, the Westchester and Sing Sing, in New York, and the Vermont marbles, are largely used for building purposes. The pillars of the Girard College, in Philadelphia, are from the Berkshire, Mass., quarries, and the rest of the building is from the Pennsylvania quarries. The marble in the New York (old) City Hall is from Massachusetts. The stone in the old Custom House, now the United States Sub-treasury, in New York, is from the Eastchester quarries. The use of marble for building purposes, particularly in New York, is to a considerable extent superseding the brown stone.

Marble from Italy, and some manufactured marble, to the amount, perhaps, of three hundred thousand dollars a year, is imported, and the United States exports an equal or larger value of manufactured marbles and other stone to Cuba and to the New Dominion. There are not less than twenty-five hundred marble and stone works in this country, whose annual manufactures amount to from twenty to twenty-five million dollars.

The brown freestone, or sandstone, quarried at Portland (formerly a part of Chatham), Conn., has been freely used in building in New York, Boston, Philadelphia, and other cities. These quarries, which are opposite Middletown, on the Connecticut River, have been worked more than a century, and stone in them is now taken out at a depth of more than two hundred feet below the river. In these quarries were found, in 1802, many feet below the surface, fossil footprints of gigantic birds, some of the prints measuring sixteen inches in length and ten in width, while the tracks were from four to six feet apart. Whole streets, in the upper part of New York, are lined with brown stone fronts from the Portland quarries; but the most of these are ashler fronts, of a thin veneering of brown stone, backed with brick. This stone works easily into the most ornamental forms; but it is liable to be affected by

the weather, and the frost sometimes causes it to scale and crumble.

These are the principal building stones found and used in the United States. Illinois produces an excellent marble, which is much used in Chicago and other cities. Ohio supplies a very handsome yellow stone to Cincinnati and Cleveland. In New York, of late years, a great deal of drab-colored stone, which is a freestone, but of the species generally quarried for fine grindstones, has been imported from New Brunswick and Nova Scotia, and iron for stores and hotels is largely taking the place of stone.

Several varieties of the harder sandstones, especially those found in Ulster, Greene, and Albany Counties, in New York, and along the Hudson River, are quarried in broad sheets for flagging and curbing. Similar quarries have lately been opened on the west bank of the Connecticut, between Hartford and Saybrook. A bright sandstone, containing considerable mica, has for many years been quarried in the Bolton Range, in Connecticut, and used for flagging.

In 1805 a company was incorporated in Pennsylvania for obtaining slate supplies from Northampton County, for roofing and other purposes. Since then very valuable quarries have been opened elsewhere in Pennsylvania, Vermont, New York, and Maryland. The extensive slate quarries on the Piscataquis River, forty miles above Bangor, in Maine, were opened in 1839. The slates are quarried and easily split into the desired thickness or thinness for various purposes, large quantities being used for roofing and for school slates.

The Virginia slates are generally green and purple; the New York quarries yield green, purple, and red slates, which are used in combination with other colors to give variety and figures on roofs. The Vermont quarries, including not less than one hundred different quarries between the Green Mountains and the Hudson River, produce roofing slate, material for tiles, mantels, sills, caps, billiard-table beds, and many ornamental as well as useful purposes. The machinery is extensive and perfect, and water or steam drives the cutters and planers. Occasionally large blocks are got out for monuments or bases, and the slate is of the greatest purity, while the supply seems to be inexhaustible.

Grindstones, millstones, and whetstones are quarried in New York, Ohio, Michigan, Pennsylvania, and in a few other states.

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MAINE STATE FAIR.

Committee.

Samuel Wasson, President.

S. L. Boardman, Sec'ry.

1872.